Welcome

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

JT

Welcome

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Wellness Within Your Walls

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Moderator: Jaclyn Toole
National Association of Home Builders

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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.

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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

RESPIRATORY CHANGES

- Sinus congestion
- Coughing or shortness
- of breath
- Need to increase use of asthma inhaler or other medications

COGNITIVE CHANGES

- Frequent headaches
- Foggy thinking, difficulty making decisions
- Sleep disturbance (can't sleep, can't wake up)
- Short term memory loss

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

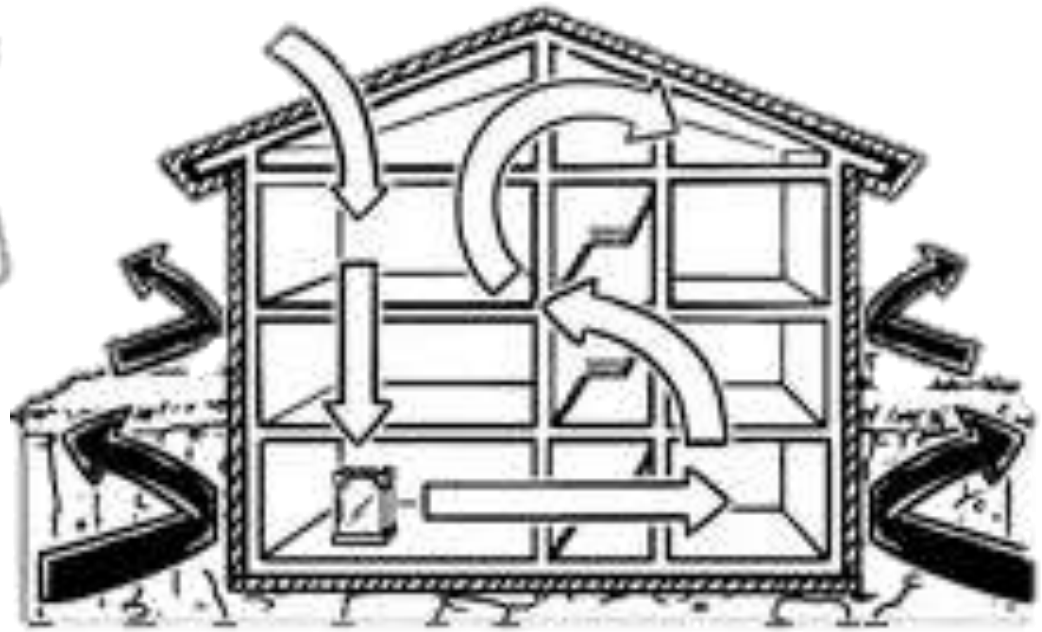
Air Quality is Impactful

- 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

$ Affordable	$$ Work Force	$$$ Market Rate	$$$$ Luxury
Quiet	Quiet	Quieter Don't Feel Allergies	Peacefully Quiet Don't Feel Allergies
Less Dirt/Dust	Much Less Dirt/Dust Low Odors Fewer Sick Days Sleep Better Cognitive Improvement +	Nearly Dust Free No Odors Few Bugs & Spiders Fewer Sick Days+ Sleep Better ++ Cognitive Improvement +	Nearly Dust Free No Odors No Bugs & Spiders Fewer Sick Days++ Sleep Better +++ Cognitive Improvement ++
Health Savings $$ Energy Savings $$$	Health Savings $$ Energy Savings $$$	Health Savings $$ Energy Savings $$$	Health Savings $$$ Energy Savings $$$

Air Quality is Impactful

Incremental Costs to Achieve Healthy Homes

based upon a 2,500 sq. ft. home

$ Affordable		$$ Work Force		$$$ Market Rate		$$$$ Luxury	
Air Sealing	$5k	Air Sealing	$5k	Air Sealing	$7k	Air Sealing	$9k
3 Purifiers	$.9k	HRV/ERV	$15k	HRV/ERV	$18k	HRV/ERV	$25k
MERV Filter	$.1k	MERV Filter	$.2k	MERV Filter	$.2k	MERV Filter	$.2k
HEPA Vac	$.7k	HEPA Vac	$.7k	HEPA Vac	$.7K	HEPA Vac	$.7k
Makeup Air	$2k	Makeup Air	$2k	Makeup Air	$2k	Makeup Air	$2k
ElectCook Top-		Induction	$1k	Induction	$1k	Induction	$1k
Garage Seal	$1k	Garage Seal	$1k	Garage Seal	$1k	Garage Seal	$2k
Less Toxic	$5k	Less Toxic	$5k	Less Toxic	$8k	Less Toxic	$10k
Dust Protocol	$1k	Dust Protocol	$1k	Dust Protocol	$1k	Dust Protocol	$2k
Clean Water	$.1k	Clean Water	$.5k	Clean Water	$1k	Clean Water	$2k
Risk Reduction	$	Risk Reduction	$	Risk Reduction	$	Risk Reduction	$$
Smaller HVAC	$3	Smaller HVAC	$4	Smaller HVAC	$5	Smaller HVAC	$6
No Gas Line to Cooktop		No Gas Line to Cooktop		No Gas Line to Cooktop		No Gas Line to Cooktop	
		No Penetrations & Bath Fans	$1	No Penetrations & Bath Fans	$2	No Penetrations & Bath Fans	$3
		Fewer Operable Windows		Fewer Operable Windows		Fewer Operable Windows	
		*Energy Calc	$1	*Energy Calc	$2	*Energy Calc	$4
			$		$$		$$$
Net Cost	$13k	Net Cost	$25k	Net Cost	$31k	Net Cost	$40k
Hayward Score 75		Hayward Score 85		Hayward Score 90		Hayward Score 94	

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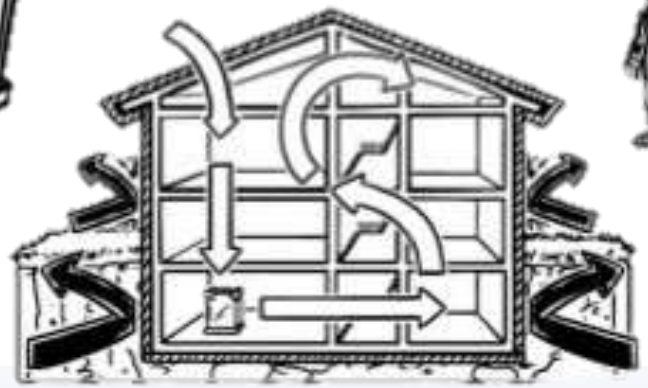
Air Quality is Impactful

Fill the House With Continuous Fresh Air

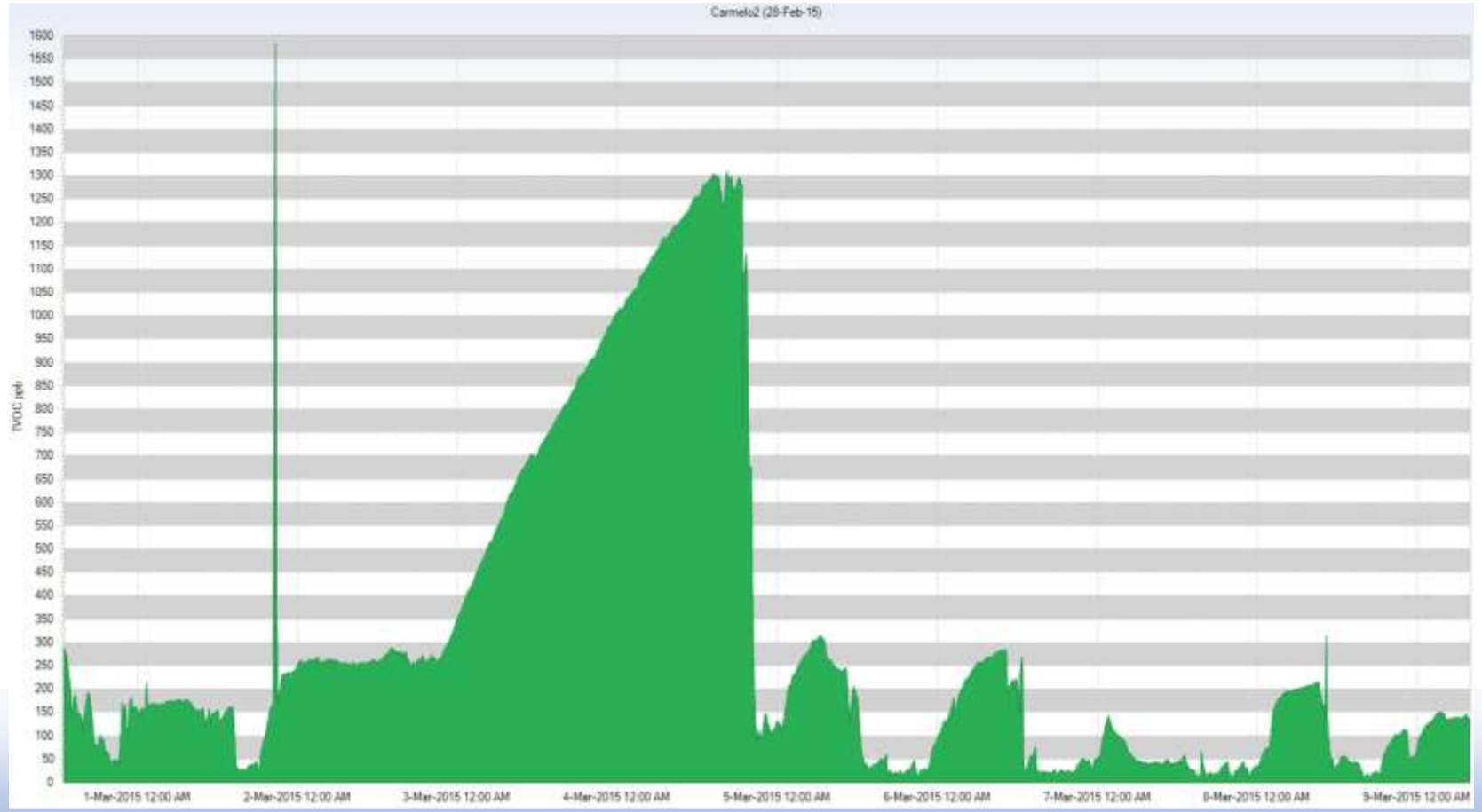
Stop The Sucking



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

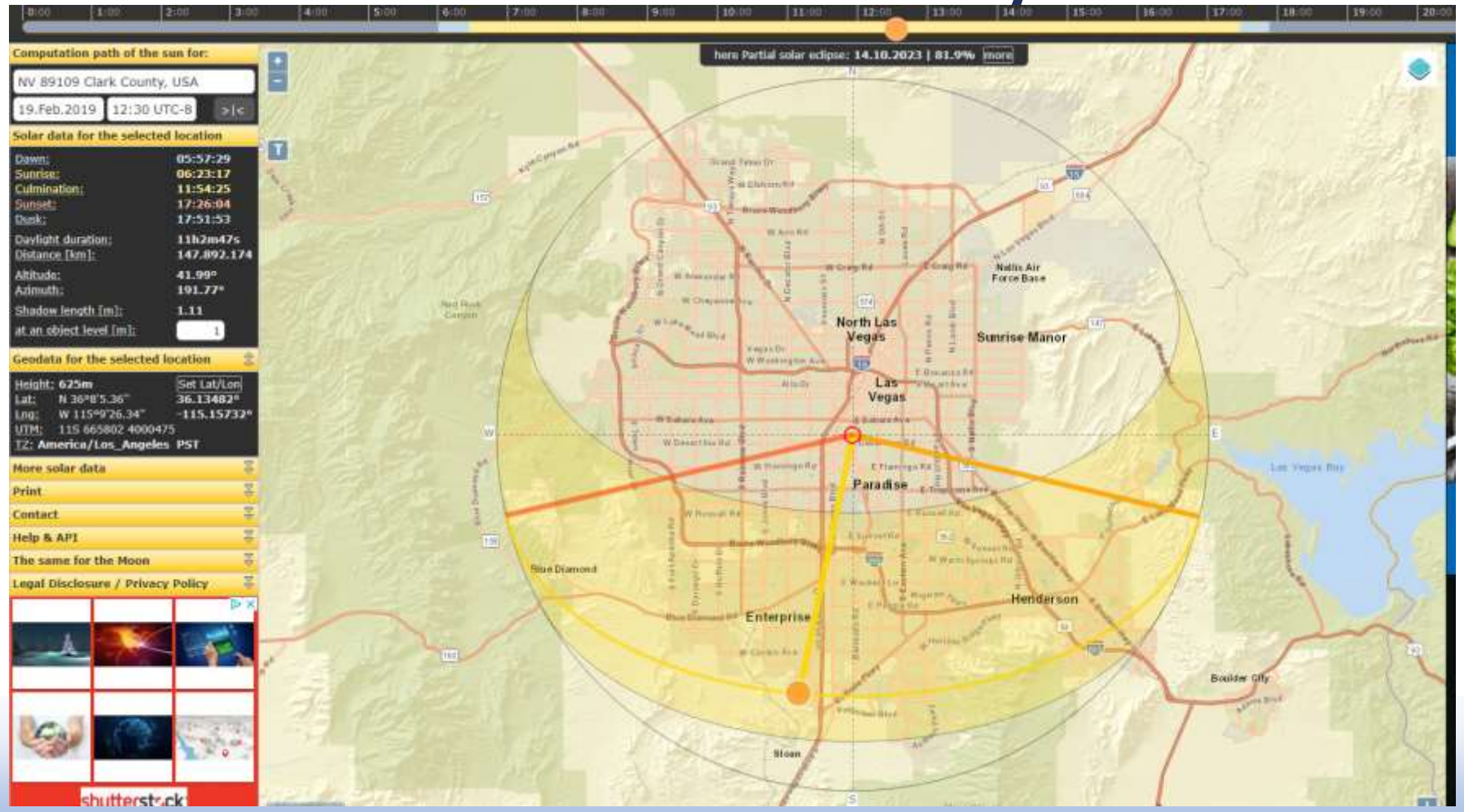
Designing Healthier Homes

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

Clean Air	Clean Water	Natural Light	Chemical Control	Physical Wellness	Spiritual Wellness	Mental Wellness	Conscious Consumption	Food Science	Behavioral Strategies
Analyze	Analyze	Expose	Analyze	Educate	Reflect	Educate	Reduce	Educate	Contemplate
Purify	Purify	Capture	Remove	Motivate	Awaken	Nurture	Reuse	Innovate	Adapt
Breathe	Hydrate	Absorb	Contain	Maintain	Flourish	Thrive	Reinvent	Provision	Maintain

Designing Healthier Homes

Sun Analysis



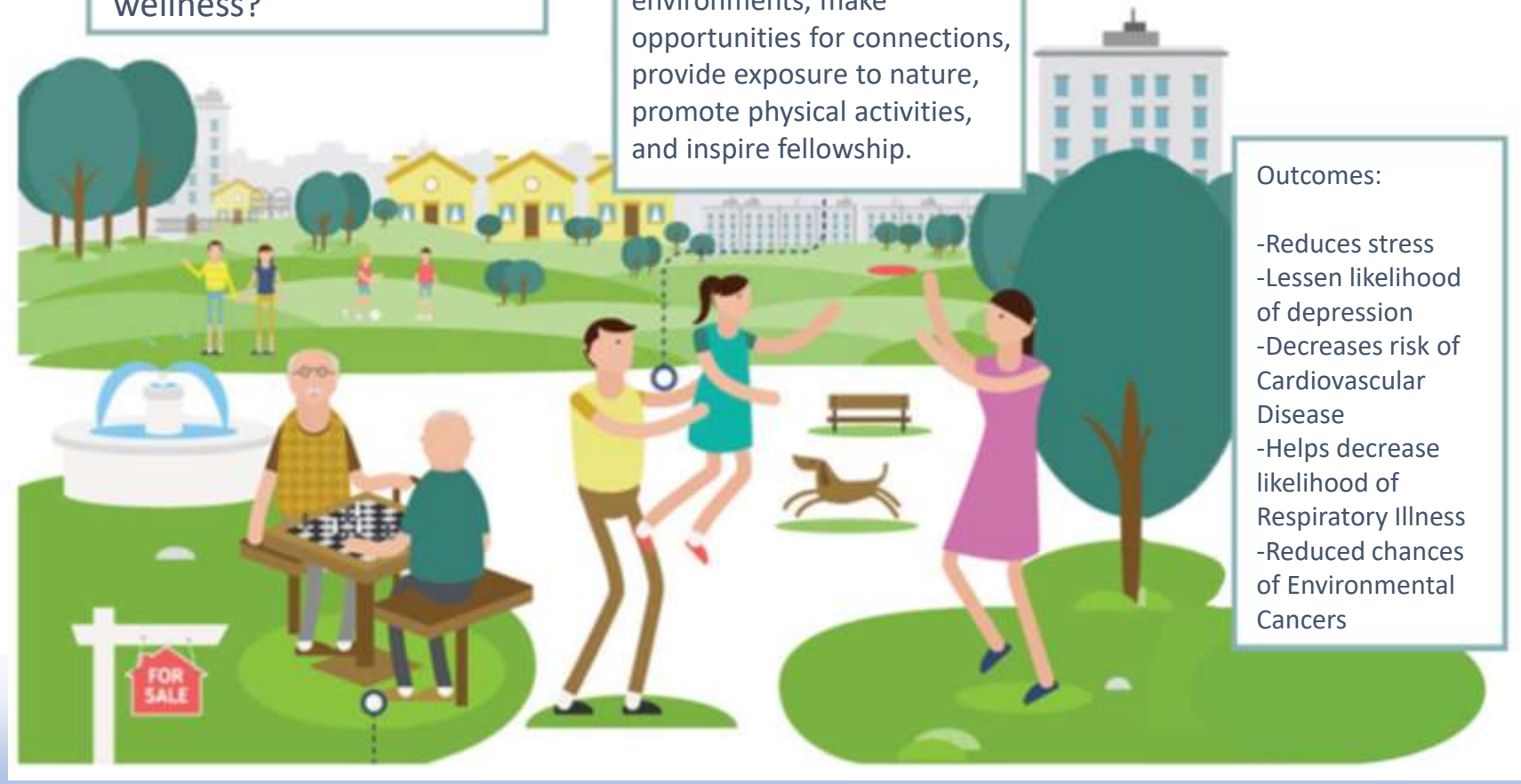
Start with natural resources. Position your homes correctly on the lot for maximum natural light exposures.

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.

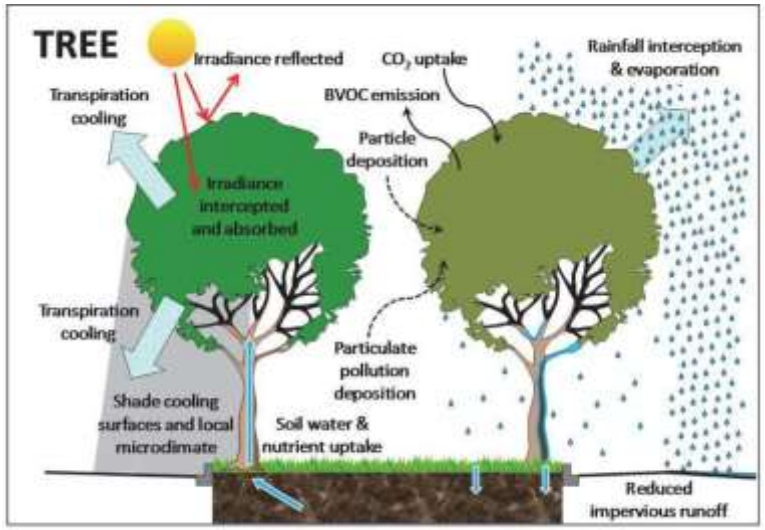


Outcomes:

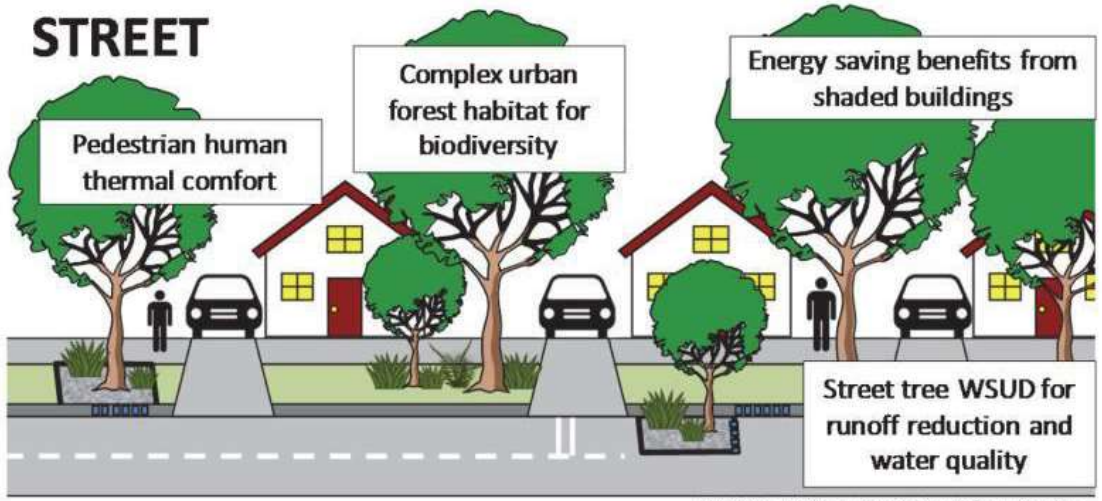
-Reduces stress
-Lessen likelihood of depression
-Decreases risk of Cardiovascular Disease
-Helps decrease likelihood of Respiratory Illness
-Reduced chances of Environmental Cancers

Designing Healthier Homes

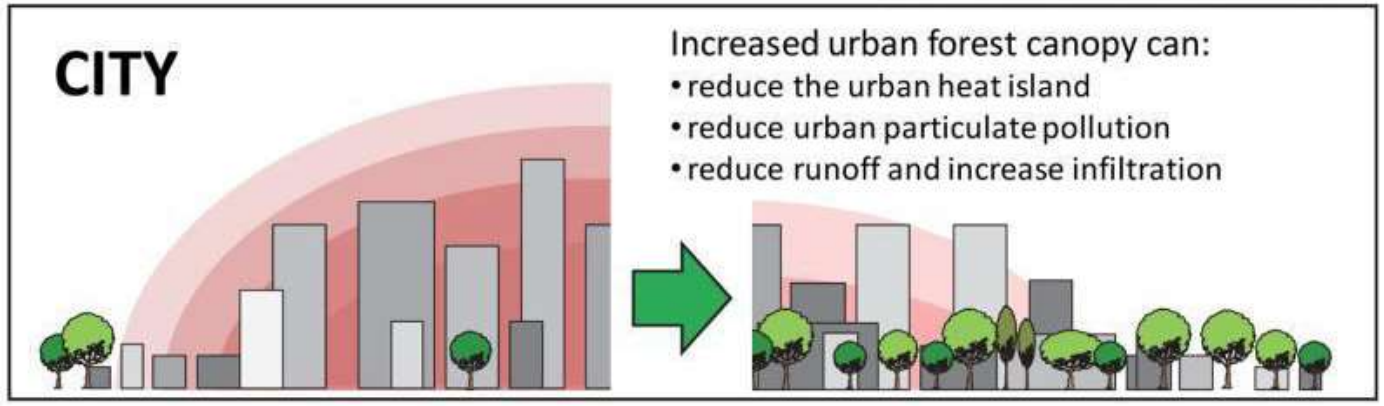
Site Analysis



BVOC = Biological volatile organic compounds



WSUD = Water Sensitive Urban Design



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

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Determining Health Outcomes

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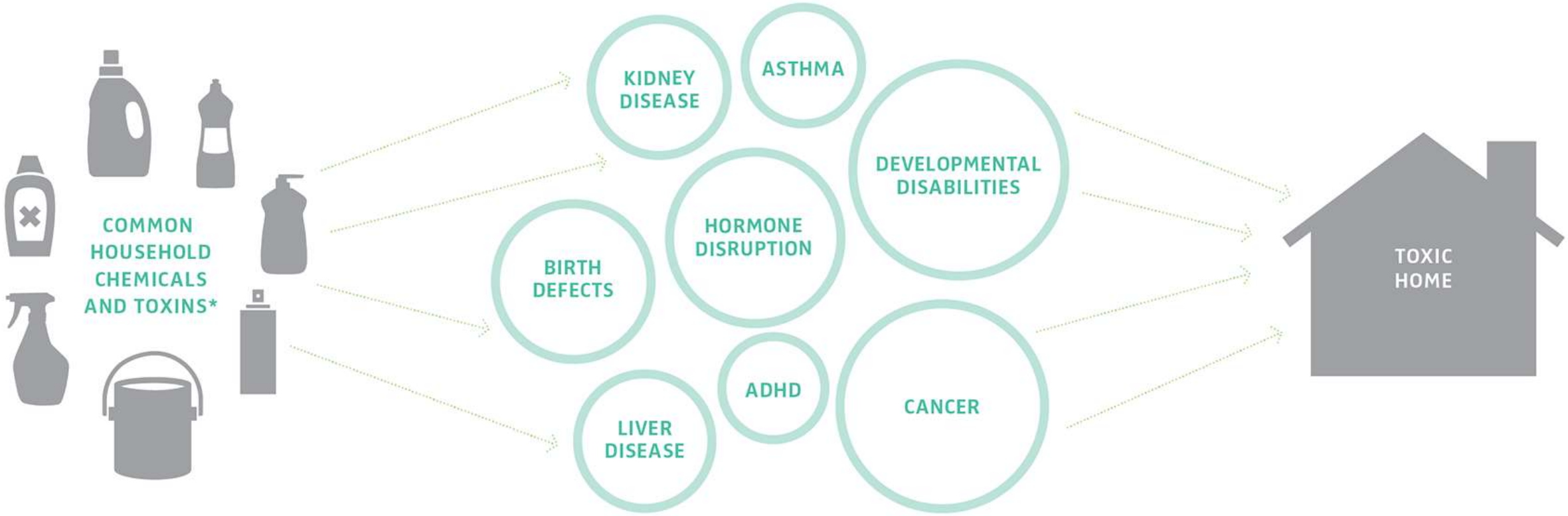
Our Built Environment



Our Built Environment

• Tobacco smoke	Cancer · Heart Disease · Respiratory Illness
• Biological contaminants	Respiratory Illness · Lung Disease · Stress
• Combustion by-products	Cancer · Respiratory Illness · Lung Disease
• Household products	Cancer · Respiratory Illness · Diseases (neurological)
• Toxic materials	Cancer · Respiratory Illness · Diseases (neurological)
• Radon	Cancer
• Safety & security	Stress
• Diet & Exercise	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

Assembly	Component	Location	Occupant Exposure	Materials to Avoid	Concerns	Alternatives	Brand
Foundation	Concrete	Exterior	Negligable		Cement: C02 & heavy metal emissions, airborne pollution, quarrying	Superior Wall (extruded polystyrene foam insulation)	
	Waterproofing	Exterior	Negligible		Styrene-butadiene (possble carcinogen)	Drainage Boards/Mats	
	Drainage Mat	Exterior	Negligible				
	PVC Drainage	Exterior	Negligible	Polyvinyl Chloride (PVC)	Manufacturing Concerns		
	Masonry	Exterior	Negligible				
	Masonry Ties	Exterior	Negligible				
	Slab Insulation	Interior	Negligible	EPS, XPS, Polyiso	(MDI) methylene diphenyl diisocyanate	Cellular Glass Insulation	FoamGlas
BG Walls	Studs	Interior	Moderate				
	Insulation	Interior	Moderate	Spray Foam Insulation	Isocyanates, MDI, polyols (catalysts)	mineral wool	
	Drywall	Interior	Certain	paper faced	mold/moisture	paper-less board	Dense Shield
	Drywall Sealant	Interior	Certain		toluene diisocyanates (TDIs)	California Air Resources Board (CARB) compliant	

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Building Materials

Assembly	Component	Location	Occupant Exposure	Materials to Avoid	Concerns	Alternatives	Brand
Floor	Floor Joists	Interior	Moderate		Urea Formaldehyde Binders	Methal diisocyanate (MDT), Phenol-resorcinol Formaldehyde	Timberstrand
	Floor sheathing	Interior	Moderate	OSB	Formaldehyde	HPVA compliant (meets CARB)	Plywood, AdvanTech
	Subfloor Sealant	Interior	Certain		toluene diisocyanates (TDIs)	California Air Resources Board (CARB) compliant	Armstrong
	Rim Joist Insulation	Interior	Moderate	Spray Foam Insulation	Isocyanates, (MDI) methylene diphenyl diisocyanate; polyols (catalysts)	blown fiberglass w/ low VOC sealant	Johns Manville, Knauf
AG Walls	Cavity Insulation	Interior	Moderate	Spray Foam Insulation	Isocyanates, MDI, polyols (catalysts)	blown fiberglass w/ low VOC sealant	Johns Manville, Knauf
	Continuous Insulation	Exterior	Negligible	EPS, XPS, Polyiso	MDI	mineral wool	Insulated ZIPS
	Sheathing/Air Barrier	Exterior	Negligible	Particle Board	Binders	Hardwood sheathing	ZIPS
	Drywall	Interior	Certain	paper faced	mold/moisture	paper-less	

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Building Materials

Assembly	Component	Location	Occupant Exposure	Materials to Avoid	Concerns	Alternatives	Brand
Roof	Rafters	Interior	Moderate				
	Sheathing	Exterior	Negligible			Hardwood sheathing	ZIPS
	Cavity Insulation	Interior	Moderate	Spray Foam Insulation	Isocyanates, (DMI) methylene diphenyl diisocyanate; polyols (catalysts)	blown fiberglass w/ low VOC sealant	
	Continuous Insulation	Exterior	Negligible	EPS, XPS, Polyiso	MDI		
	Ice & Water Shield	Exterior	Negligible	Petroleum, Asphalt	polynuclear aromatic compounds (PACs) Possible Carcinogen		
	Roofing	Exterior	Negligible	Asphalt	PACs		
	Penetration Sealant	Exterior	Moderate				
DHW	Pipe	Interior	Certain		ethyltertbutyl ether (ETBE)	NSF's Standard 61 tested PEX	
	Insulation	Interior	Moderate			low VOC	Armacell

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Building Materials

- Global Warming Potential (GWP)
- Embodied Carbon
- Life Cycle Analysis (LCA)

Building Materials

- 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

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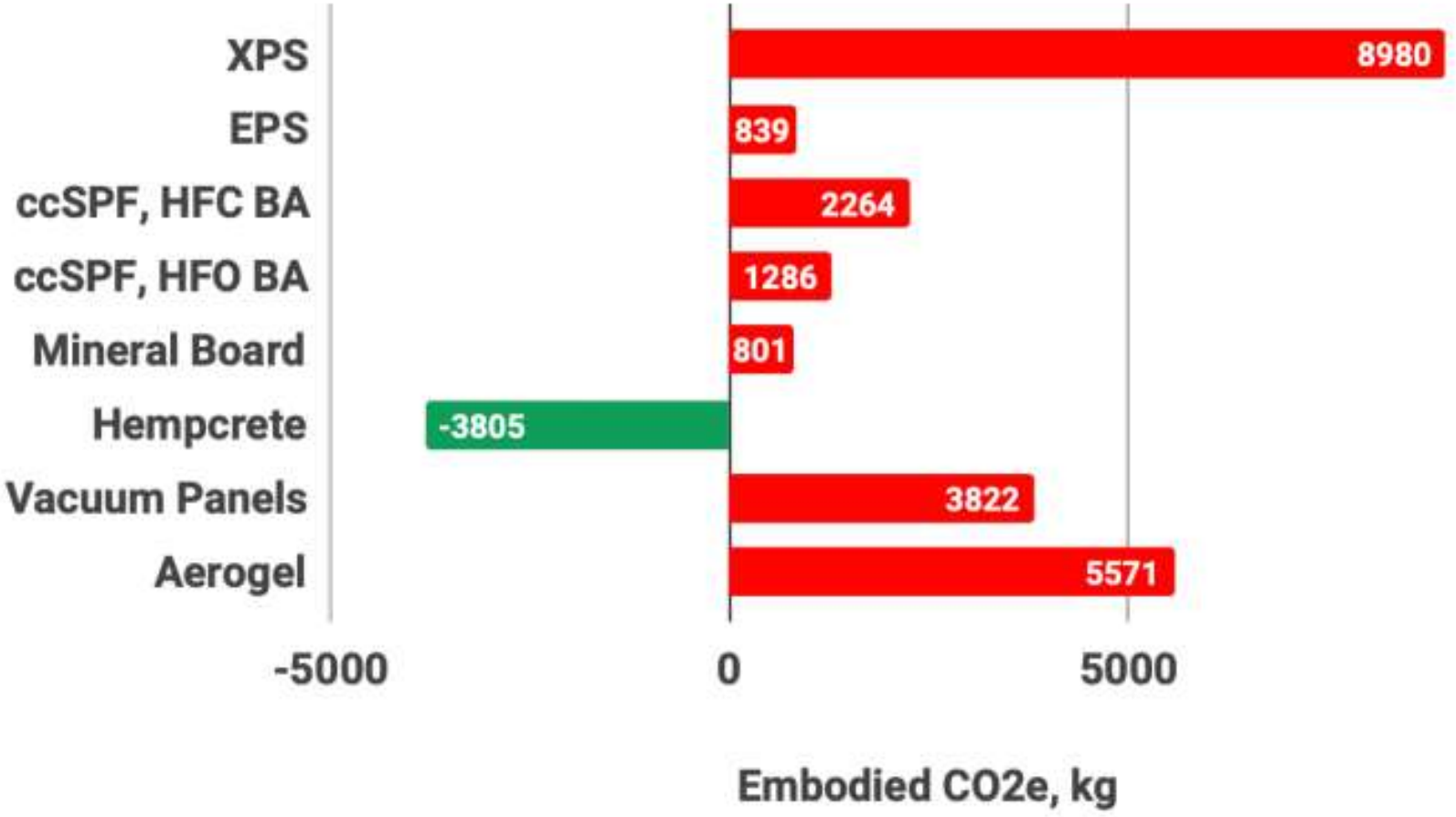
Building Materials

Building Materials



R20 Foundation Wall Insulation CO2e

Slide credit: Jacob Racusin

Building Materials

Plant Based
Carbon Storing
Building Materials

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Building Science Basics

Existing · Crawl Space

Crawl Space Exhaust Fan

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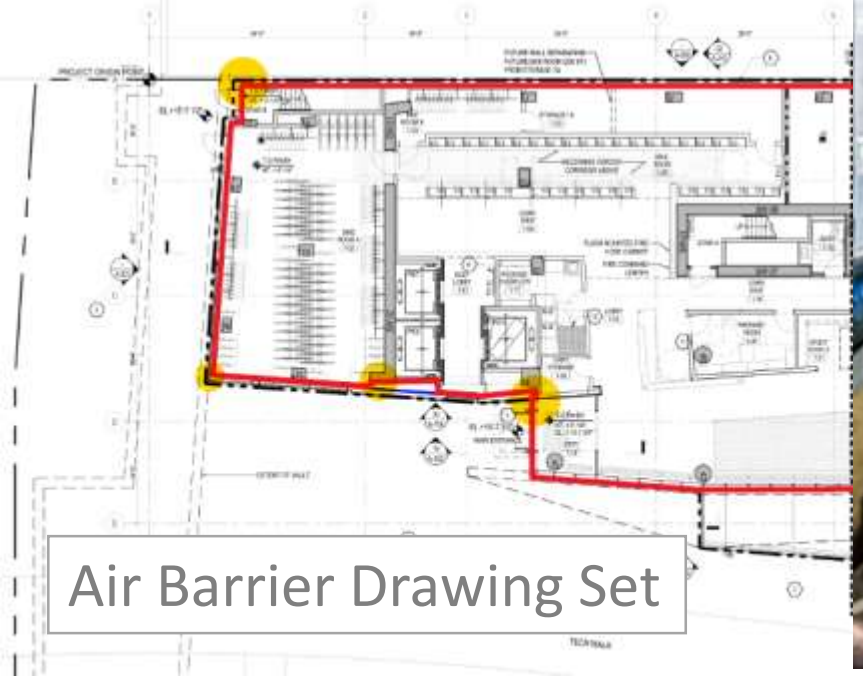
Building Science Basics

ENCLOSURE

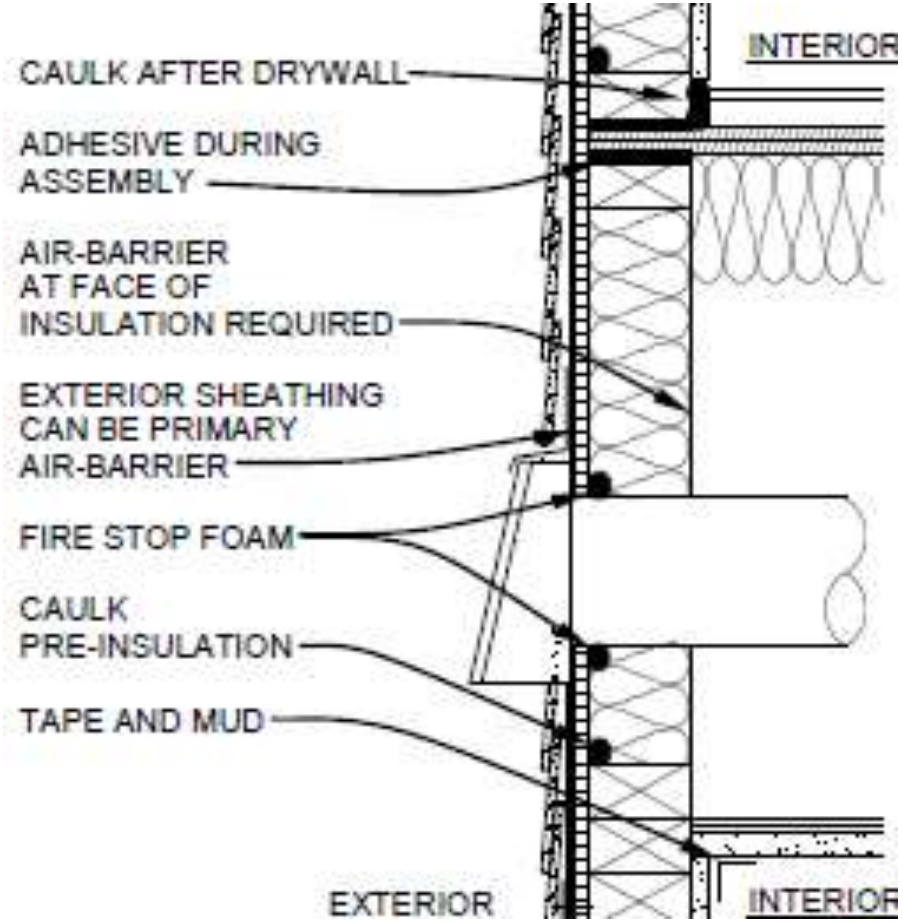
CONTINUITY OF AIR BARRIER



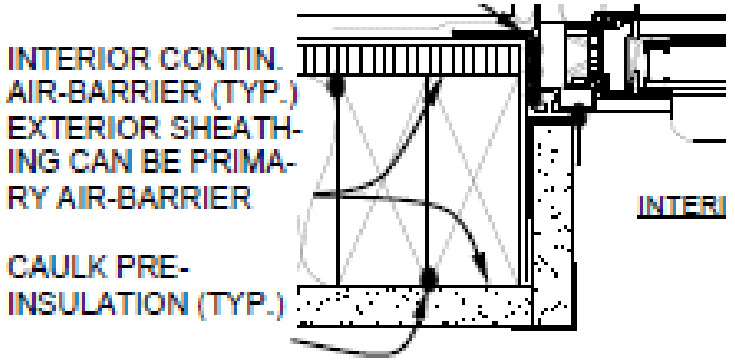
Air Barrier Drawing Set

Air Barrier Installed

Building Science Basics



Air Sealing Design



Air Sealing Construction

Building Science Basics

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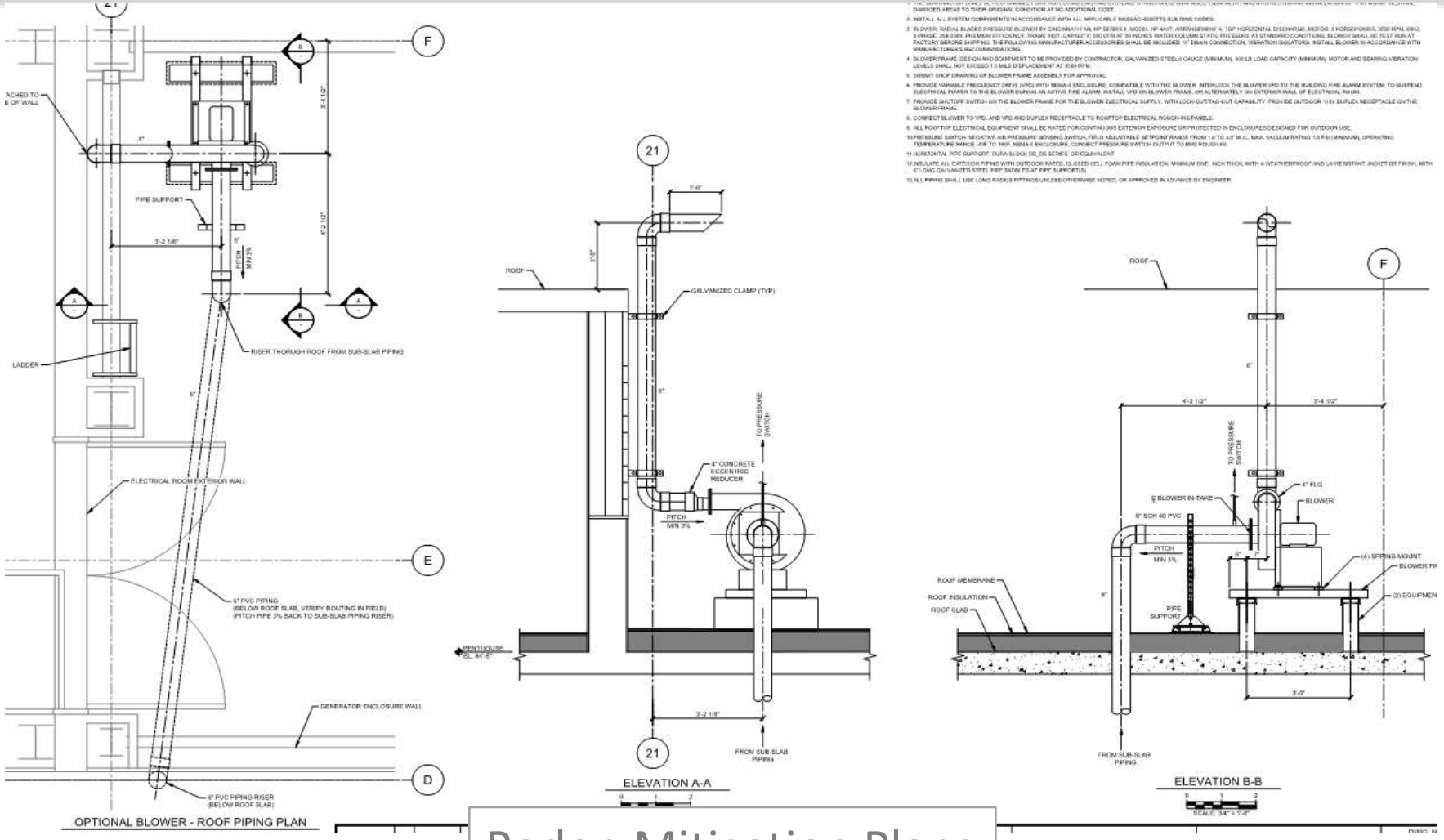
Building Science Basics



Radon Mitigation Plans

HVAC

14	90-95%	>98%	Most Tobacco Smoke	Smoking Lounges	synthetic media, 12-36 in. deep, 6-12 pockets
13	89-90%	>98%	Proplet Nuceli (Sneeze)	Superior Commercial Buildings	**Box Filter**- Rigid Style Cartridge Filters 6 to 12" deep m ay use lofted or paper media.
12	70-75%	>95%	1.0-3.0 pm Particle Size Legionella	Superior Residential	**Bag Filter**- Nonsupported microfine fiberglass or synthetic media, 12-36 in. deep, 6-12 pockets
11	60-65%	>95%	Humidifier Dust Lead Dust	Better Commercial Buildings	
10	50-55%	>95%	Milled Flour Auto Emissions	Hospital Laboratories	**Box Filter**- Rigid Style Cartridge Filters 6 to 12" deep m ay use lofted or paper media.
9	40-45%	>90%	Welding Fumes		
8	30-35%	>90%	3.0-10.0 pm Particle Size	Commercial Buildings	**Pleated Filters**- Disposable, extended surface area, thick with cotton-polyester blend media

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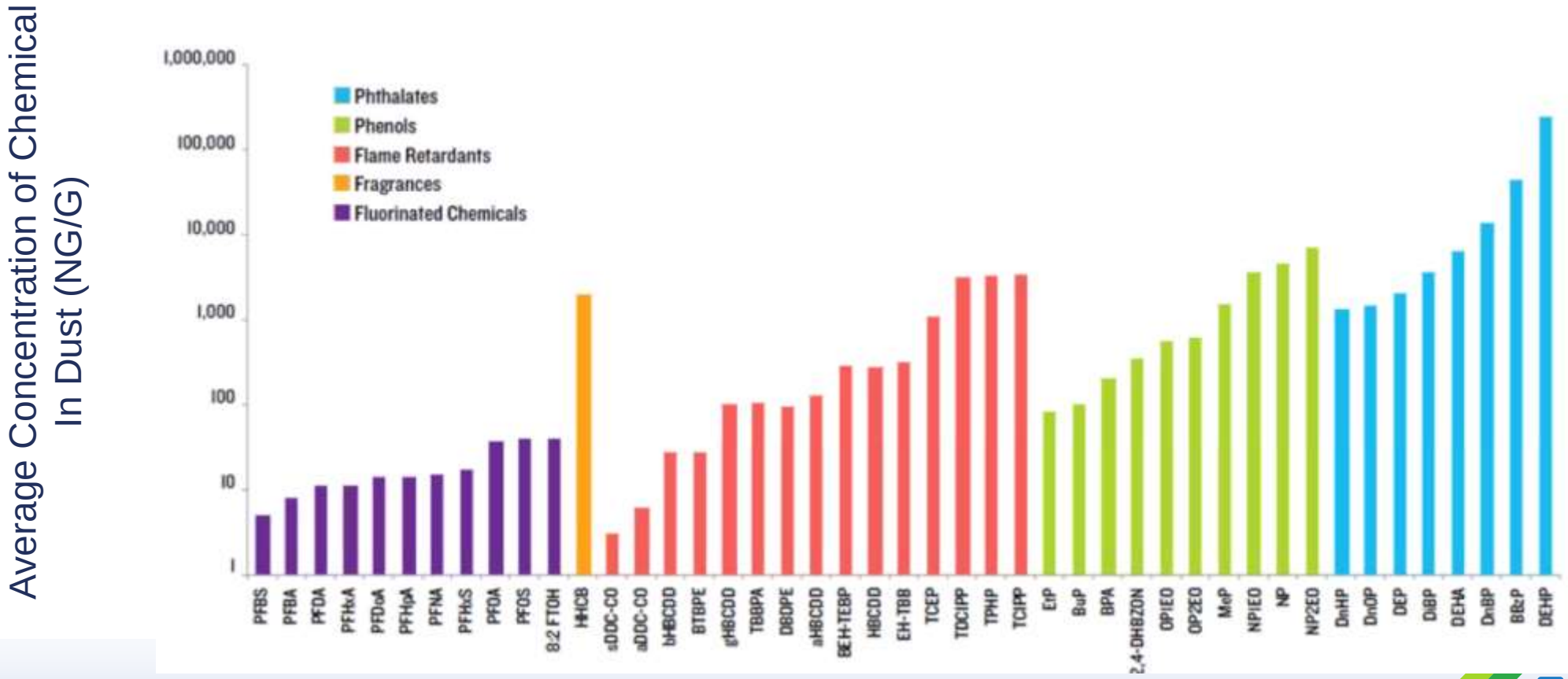
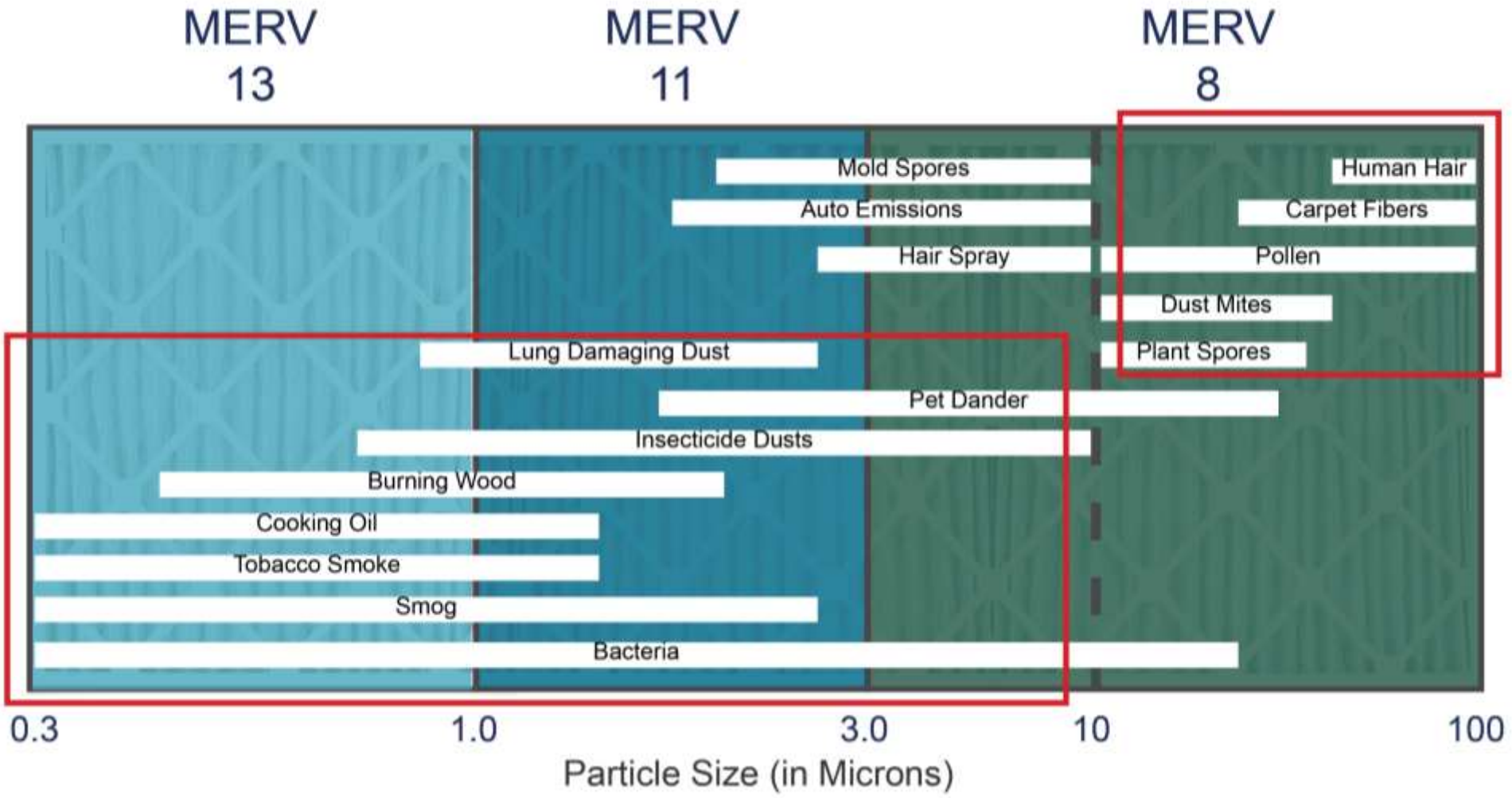
HVAC

Good Filtration Because it's Not Just Dirt



EEBA

HVAC


MERV 13
MERV 11
MERV 8
Mold Spores
Auto Emissions
Hair Spray
Lung Damaging Dust
Pet Dander
Insecticide Dusts
Burning Wood
Cooking Oil
Tobacco Smoke
Smog
Bacteria
Human Hair
Carpet Fibers
Pollen
Dust Mites
Plant Spores
0.3
1.0
3.0
10
100
Particle Size (in Microns)

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Air Quality is Impactful

Cost-Effective Healthy Homes

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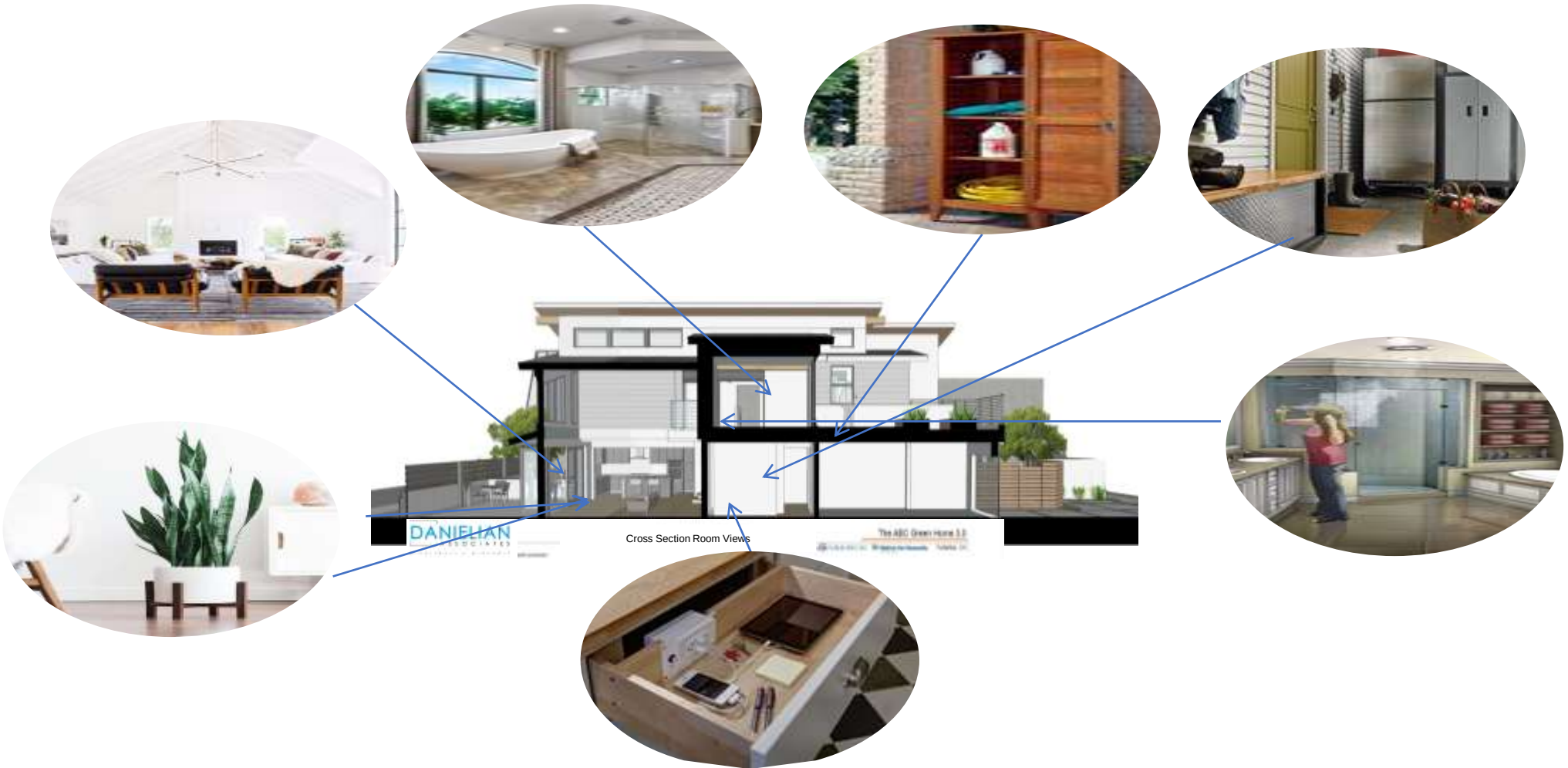
Air Quality is Impactful

Cost Effective Healthy Homes



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Air Quality is Impactful

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

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Air Quality is Impactful

https://naturalleader.com/thecogfxstudy/study-2/

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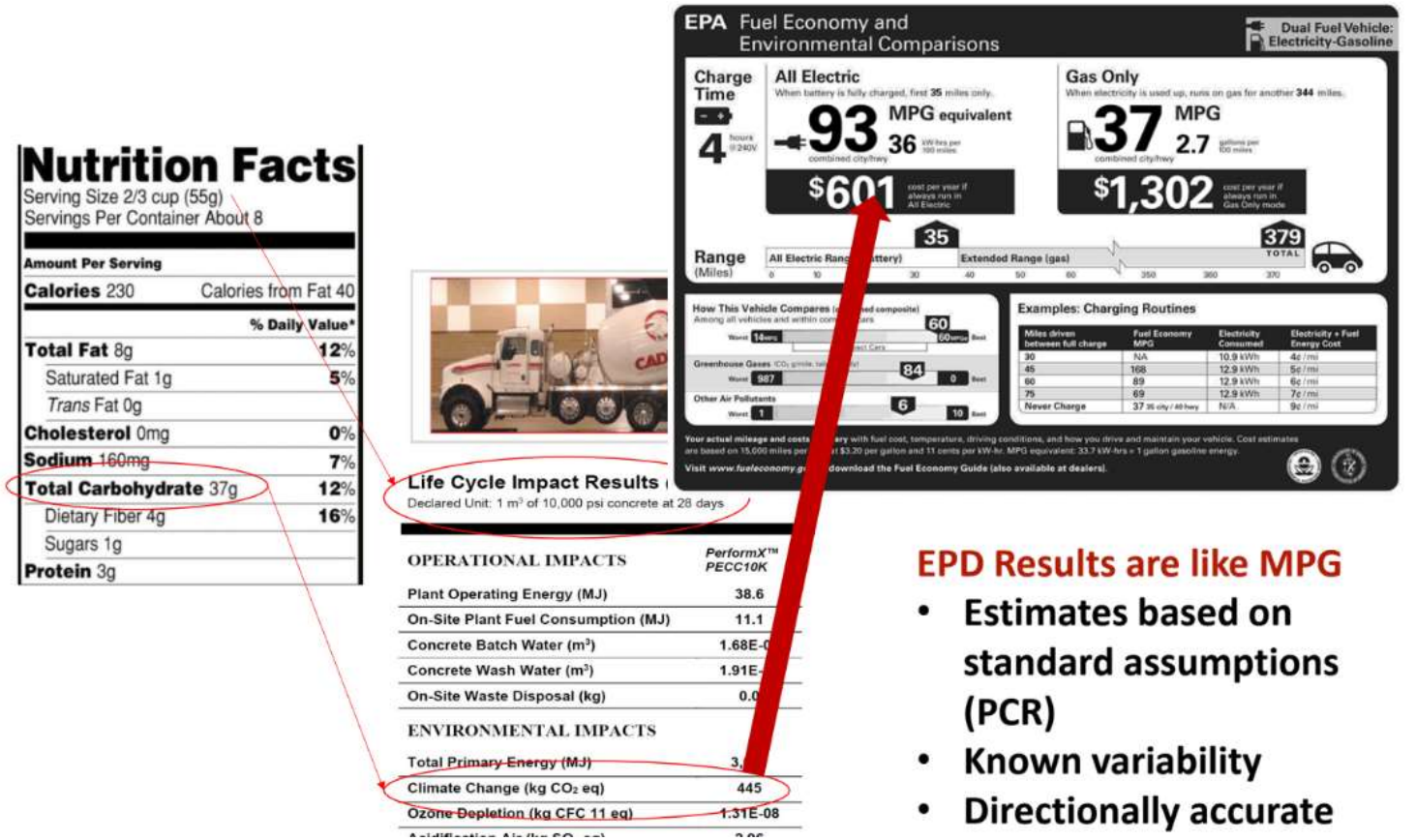
More Solutions

EPDs Enable Embodied Carbon Transparency

Environmental Product Declarations



Nutrition Facts
Serving Size 2/3 cup (55g)
Servings Per Container About 8

Amount Per Serving	
Calories 230	Calories from Fat 40
	% Daily Value*
Total Fat 8g	**12%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**12%**
Dietary Fiber 4g	**16%**
Sugars 1g	
Protein 3g	

EPA Fuel Economy and Environmental Comparisons — Dual Fuel Vehicle: Electricity-Gasoline

Charge Time: 4 hours @ 240V

All Electric: 93 MPG equivalent; 36 kW-hrs per 100 miles; $601 cost per year if always run in All Electric

Gas Only: 37 MPG; 2.7 gallons per 100 miles; $1,302 cost per year if always run in Gas Only mode

Range (Miles): 35 (All Electric Range / Battery); Extended Range (gas); 379 TOTAL

How This Vehicle Compares: 60 (Best); Greenhouse Gases: 84 (Best 0); Other Air Pollutants: 6 (Best 10)

Examples: Charging Routines

Miles driven between full charge	Fuel Economy MPG	Electricity Consumed	Electricity + Fuel Energy Cost
30	N/A	10.9 kWh	4¢ / mi
45	168	12.9 kWh	5¢ / mi
60	89	12.9 kWh	6¢ / mi
75	69	12.9 kWh	7¢ / mi
Never Charge	37	N/A	9¢ / mi

Visit www.fueleconomy.gov to download the Fuel Economy Guide (also available at dealers).

Life Cycle Impact Results
Declared Unit: 1 m³ of 10,000 psi concrete at 28 days

OPERATIONAL IMPACTS	PerformX™ PECC10K
Plant Operating Energy (MJ)	38.6
On-Site Plant Fuel Consumption (MJ)	11.1
Concrete Batch Water (m³)	1.68E-0
Concrete Wash Water (m³)	1.91E-
On-Site Waste Disposal (kg)	0.0
ENVIRONMENTAL IMPACTS	
Total Primary Energy (MJ)	3,
Climate Change (kg CO_2 eq)	445
Ozone Depletion (kg CFC 11 eq)	1.31E-08

EPD Results are like MPG

- Estimates based on standard assumptions (PCR)
- Known variability
- Directionally accurate

Slide credit: Kate Simonen, AIA

More Solutions

PROJECT SPONSORS

CHARLES PANKOW FOUNDATION

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Interface

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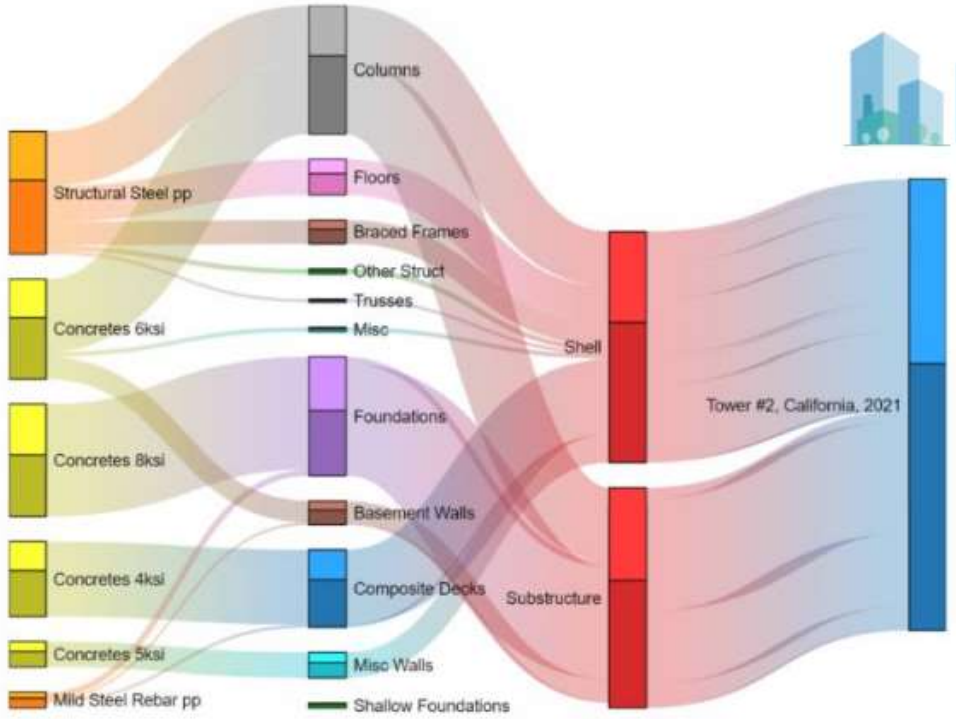
EC3: Embodied Carbon Calculator for Construction



PROJECT LEADERSHIP

CLF Carbon Leadership Forum UNIVERSITY of WASHINGTON

cchange labs 2019

Slide credit: Kate Simonen, AIA

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More Solutions

Point of Service Water System

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Personal Filtration

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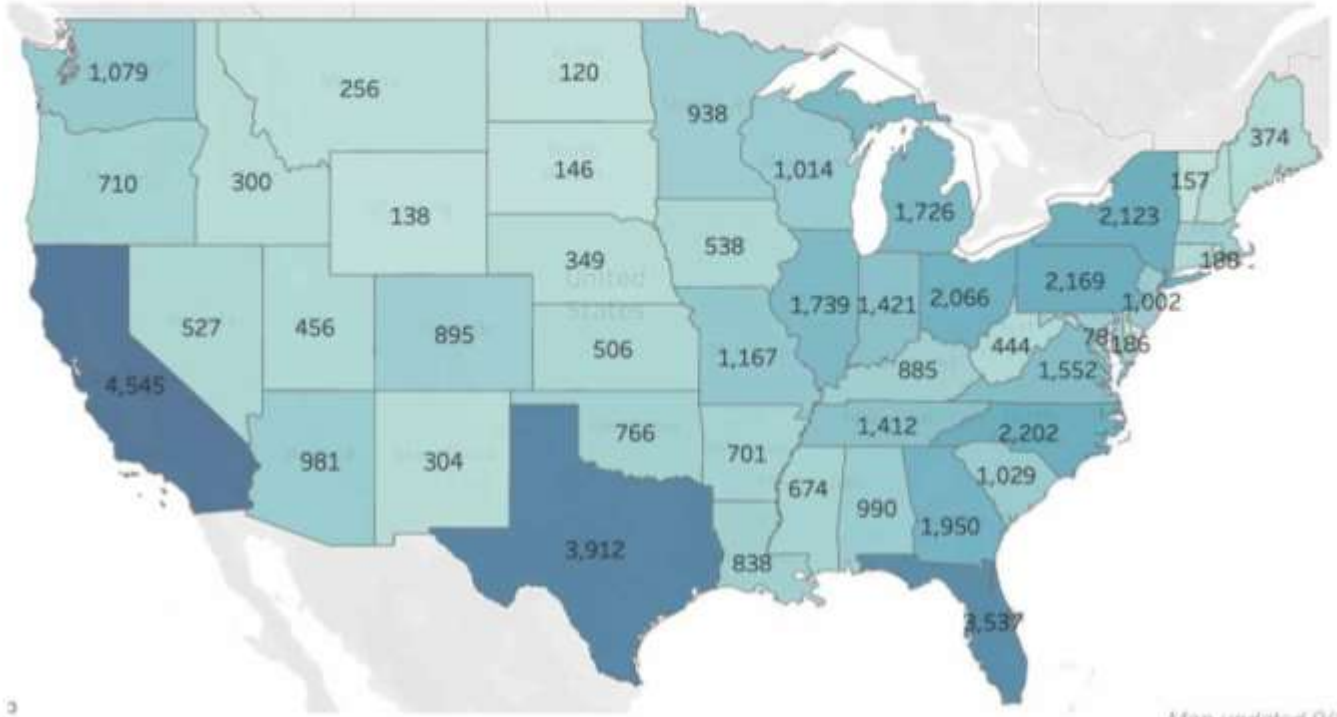
Clothing Refresher

More Solutions

Largest Database of Health/Housing

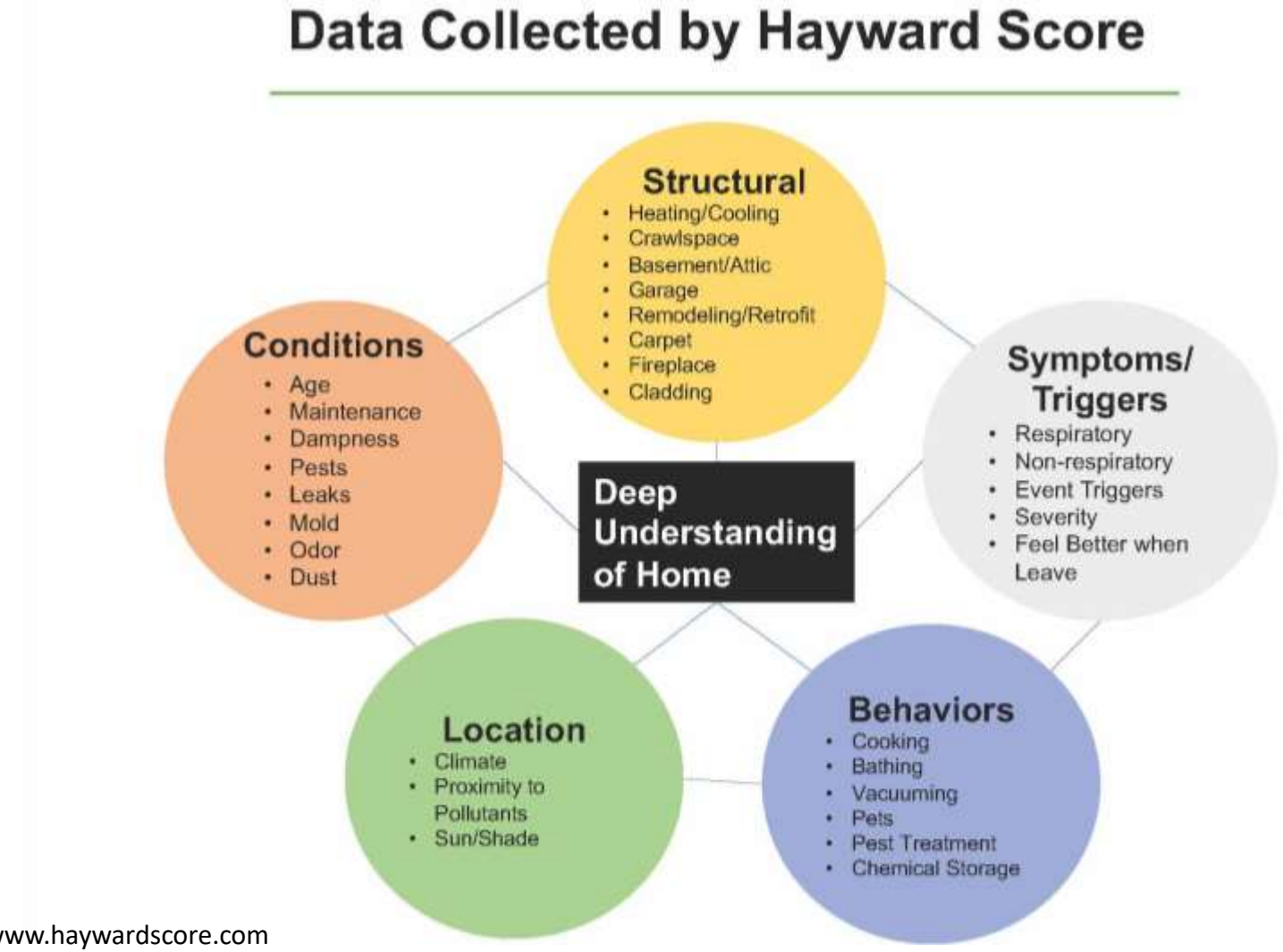
Over 53,000 people across the US have scored their homes

Hayward Score has Largest Database of Health/Housing Related Information



Slide credit: Hayward Score, www.haywardscore.com

More Solutions



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://www1.eere.energy.gov/buildings/publications/pdfs/building_america/multi-family_air_sealing_guide.pdf

https://www.haywardscore.com/

K

Questions???

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JT

Thank you!

Join the conversation - #EEBASummit2019

Save the dates for next year:

EEBA