

# What's A Green Material? Many Views, Questions and Issues

Hal Levin, B.Arch.  
Fellow ASHRAE

Building Ecology Research Group, Santa Cruz, CA

[Hal.Levin@BuildingEcology.com](mailto:Hal.Levin@BuildingEcology.com)

[www.BuildingEcology.com](http://www.BuildingEcology.com)

# Green Materials for Green Buildings

- Many criteria
- Many diverse labeling programs
- Many definitions
- Many different perspectives
- Many potential conflicting criteria!



# What does “Green” mean? Who Decides?

- Green Globes
- USGBC LEED Rating System
- Scientific Certification Systems
- GreenGuard
- GreenSeal
- CRI Green Label Plus
- Danish Indoor Climate Labeling Program
- European Union – Ecolabel (The Flower)
- German - Blue Angel
- Finland – Indoor Climate Classification
- etc., etc., etc.,

# What Makes a Material Green?



# What's in a Name?—Eco-Labels?

*“Labels can conceal more than they reveal”*

(U.S. Senator Arlen Specter, August 24, 2005, PBS Evening News)

**SUSTAINABLE**

**LEED™ Certified**

Environmentally friendly ☺

Safe



*100% Natural*

**DANGER**

**FLAMMABLE**

**Non-toxic**

*Formaldehyde free*

**Low VOC**

# Building-Related Ecological and Human Health Impacts

## Ecological Health Problems

- Habitat destruction / deterioration (biodiversity loss)
- Global climate change
- Stratospheric ozone depletion
- Soil erosion
- Depletion of freshwater resources
- Acid deposition
- Urban air pollution/smog
- Surface water pollution
- Soil and groundwater pollution
- Depletion of mineral reserves (especially oil and some metals)

## Human Health Problems

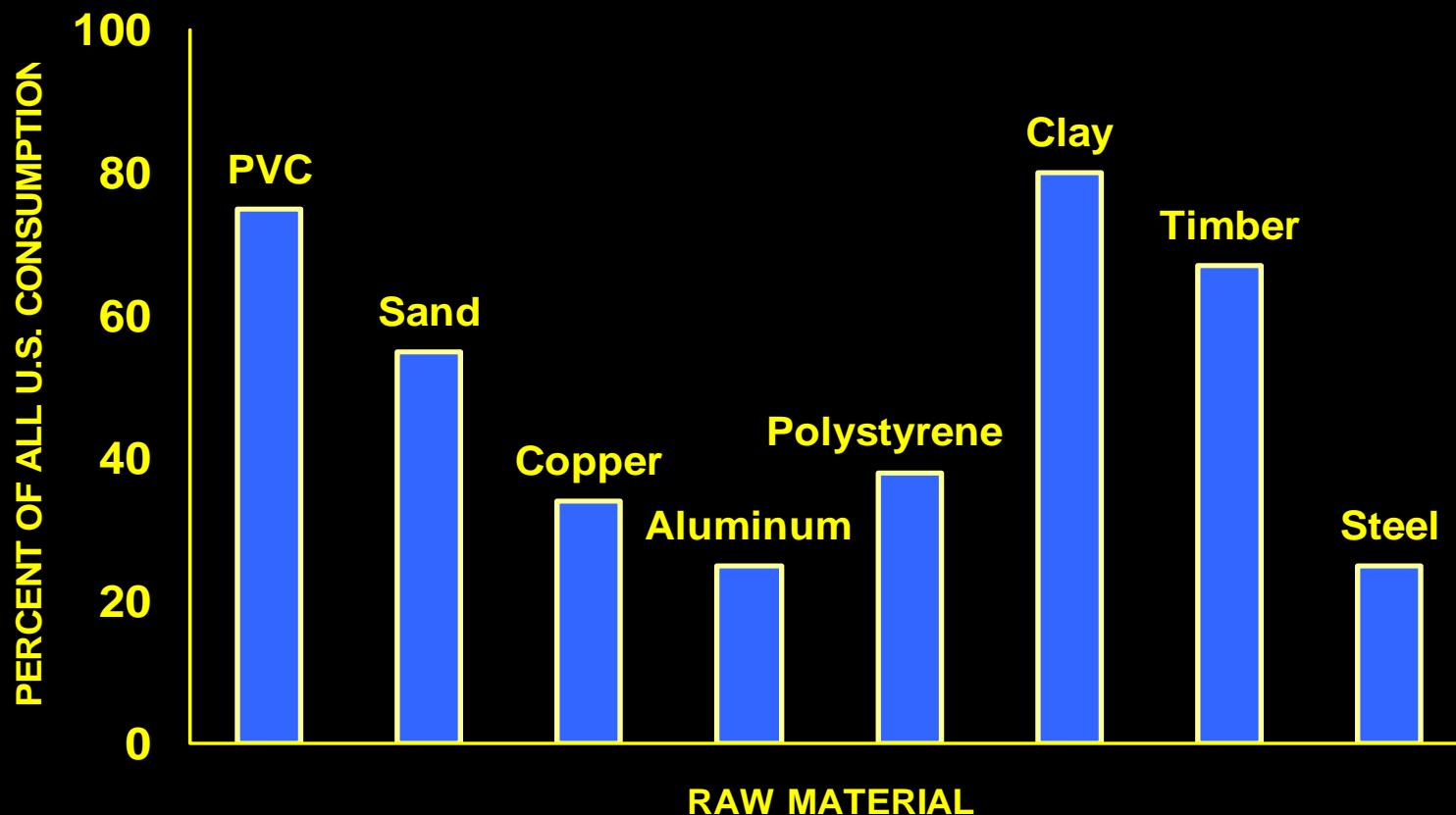
### *Building Occupants:*

- Indoor air pollution—non-radon
- Indoor air pollution—radon
- Accidents in buildings: electrical, fire, falls, etc.

### *Building Workers:*

- Building construction
- Materials manufacture
- Demolition

# Raw Materials: Burden of Buildings in Percent of US Total Consumption 1995



Source: Levin, Boerstra, and Ray, 1995.

# Building Materials “Green” Criteria

- Low impact on ecological and human health
- High recycled content
- Natural vs Synthetic
- Local source
- Short transportation distance
- Low technology – simple
- Long service life
- Easy replacement
- Easy to re-use or recycle
- Easy to clean – non-toxic cleaning process / materials
- Low embodied energy – carbon
- Appropriate for intended use – likely to be left in place for its potential service life

$$\text{Life Cycle Impact} = \frac{(\text{Embodied} + \text{Recurring Impacts})}{\text{Service Life}}$$

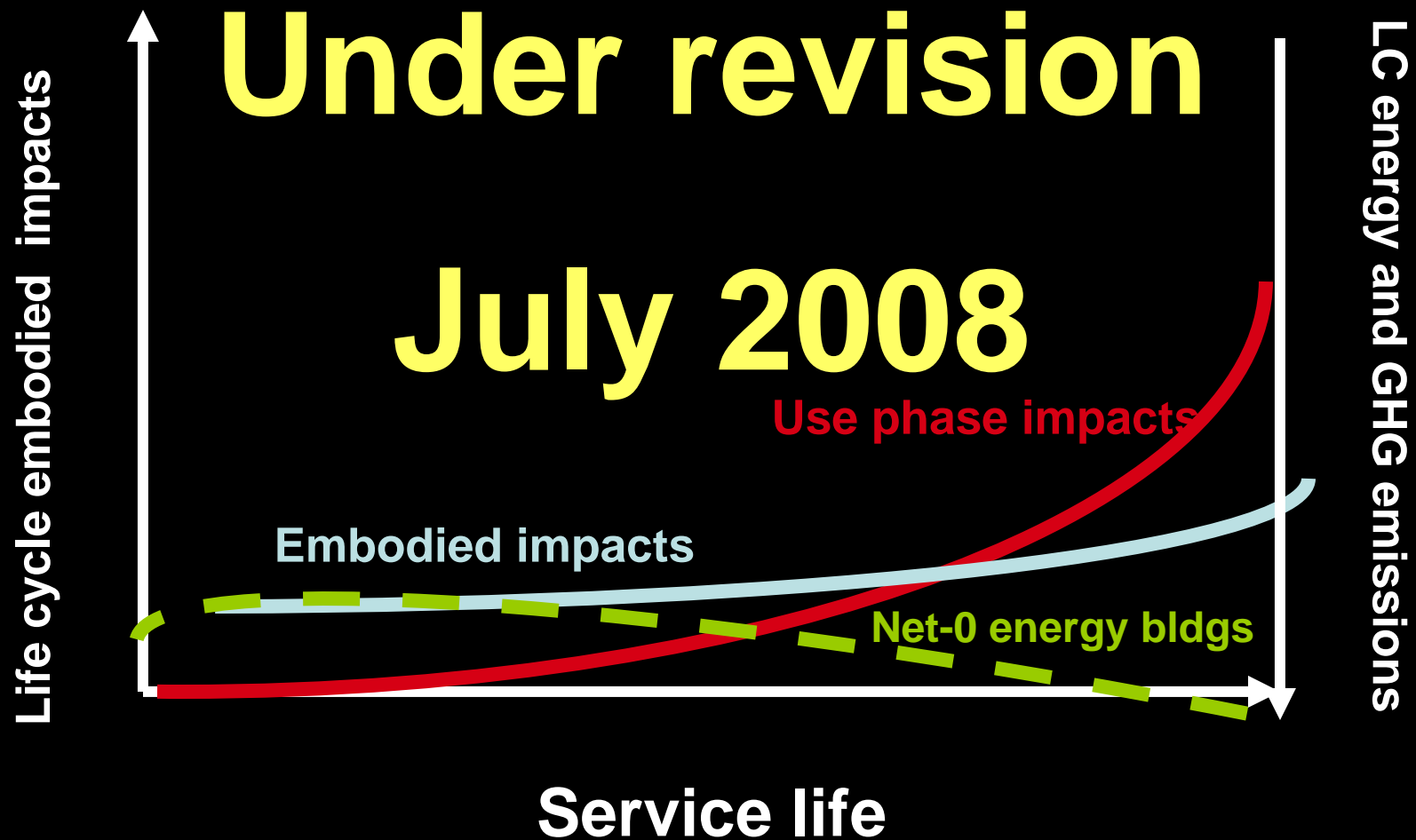
- Embodied  
resources, pollution, land encroachment
- Use phase  
resource use, pollution emissions
- Long service life  
reduces annualized embodied impacts



# Embodied vs. Use Phase Impacts

- “Green” (sustainable) buildings will generally have longer service lives
- Longer service life shifts ratio of embodied and use phase impacts toward embodied impacts.
- Zero net energy use buildings will have all their energy impacts (resource consumption, pollution emissions) in the embodied phase.

# Embodied vs Use Phase Impacts Decline Relative to Embodied Impacts in Zero-Net Energy Buildings



# Buildings Materials “Green” Criteria

## Low impact on ecological and human health

- Low emissions into indoor air
- Minimal emissions of toxic chemicals
- ‘Resistant’ to mold growth
- Low effects of moisture
- Low odor
- Biodegradable
- Durable

# Buildings Materials “Green” Criteria

- High recycled content - Advantages
  - Lower total mass flows – fundamental to sustainability
  - Reduced burden to landfills
- High recycled content - Disadvantages
  - Potential on-going exposure to toxics
  - Ex: pesticides in recycled wood - Pentachlorophenol
  - Pesticides in products made from salvaged wood – PCP, etc.
  - Tire derived products – See Alevantis presentation in this session

# Green Material Criteria

## High recycled content

Some of the salvaged wood that is used to build or remodel houses today may have been pressure treated with PCP when it was first produced. Rudel et al. (2003) found PCP in the air of 58% of 120 Cape Cod homes sampled from 1999 to 2001; its median concentration was 1.8 ng/m<sup>3</sup>. Between 2000 and 2001, Wilson et al. (2007) measured very similar levels in the air of 251 homes and 42 daycare facilities in Ohio and North Carolina. PCP is still detected in the urine of almost all U.S. residents (NHANES, 2005), a legacy of its once ubiquitous use. -- source: Weschler, 2008 *Atm Env't*, in press

# Green Material?

**Local source**

**Totally “natural”**

**Durable – long-lived**

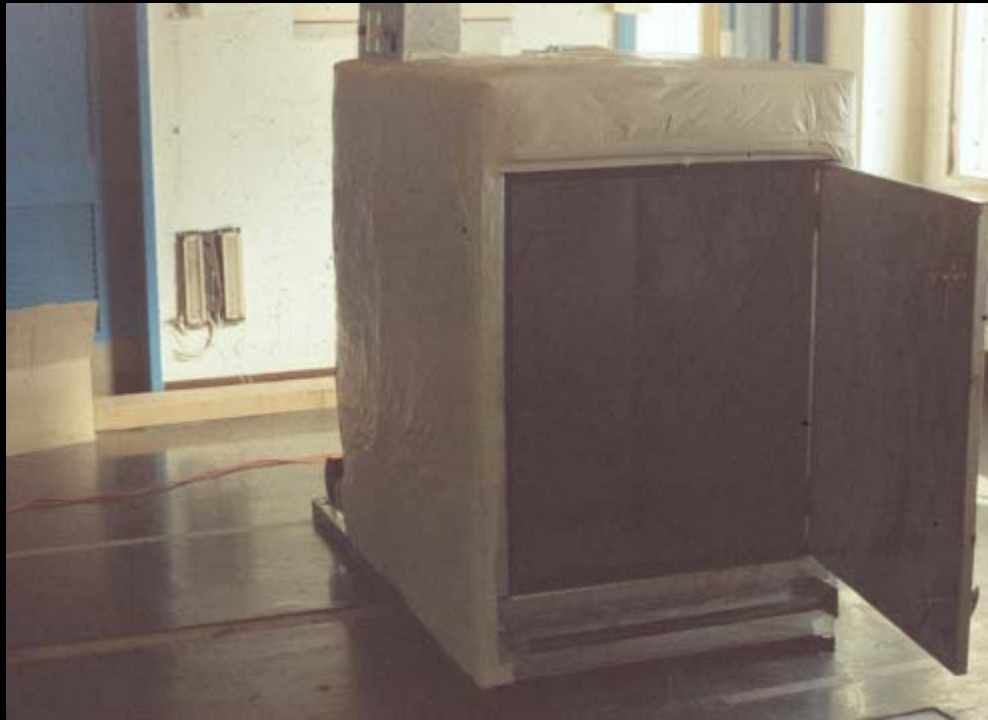
**Cleanable without  
toxics**

**Low emissions -  
hardwood**

**Swedish low VOC  
finish (\$107/gallon)**



# Low Emissions – Testing Matters



**Early emissions test chamber – Levin, 1983**

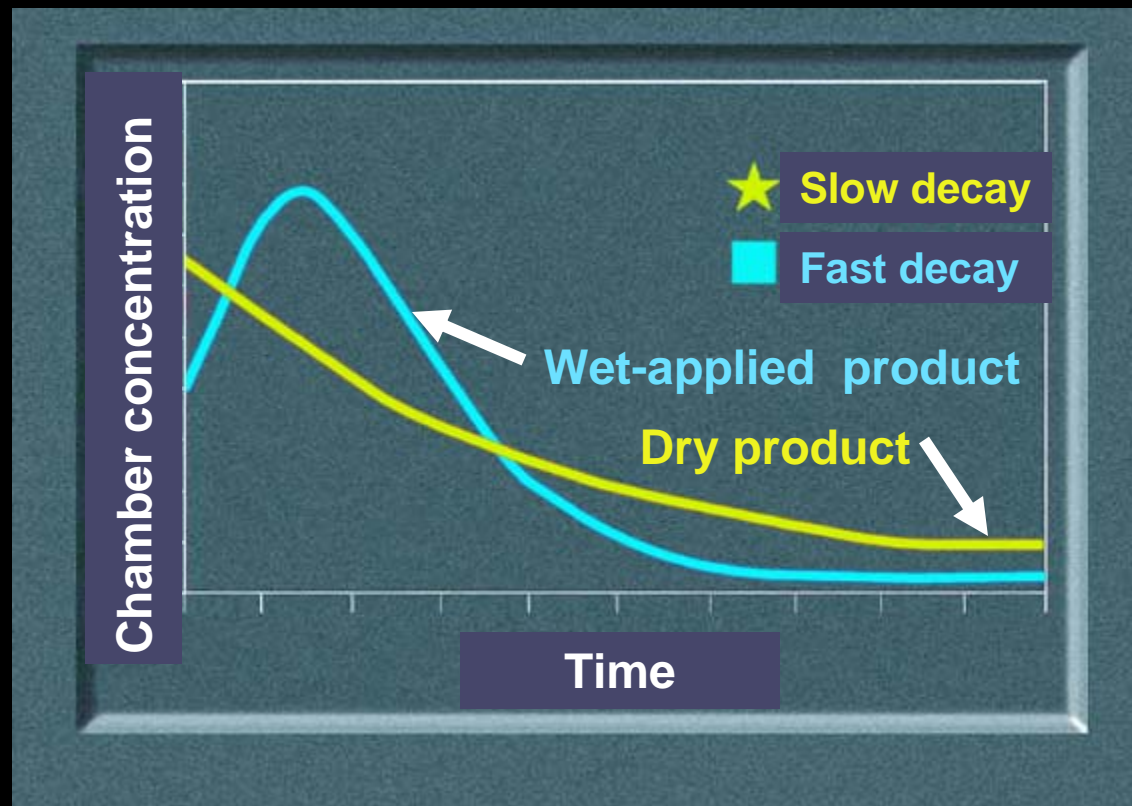


**ISPRA Test chamber - 1990**

## Emissions of What? – VOC, TVOC, SumVOC, IVOC, etc., etc., etc.

- Total Non-methane hydrocarbons
- Reactive Organic Chemicals (ROC)
- Volatile Organic Chemicals (VOC)
- Total Volatile Organic Chemicals – (TVOC)
- SumVOC – Sum of identified individual VOCs
- IVOCs – Individual Volatile Organic Chemicals
- MVOCs – Microbial Volatile Organic Chemicals
- SVOCs – Semi-Volatile Organic Chemicals
- Particles -  $<2.5 \mu\text{m}$  MMAD,  $<10 \mu\text{m}$  MMAD

# Emissions Decay Over Time – But at Different Rates, so what is Green?

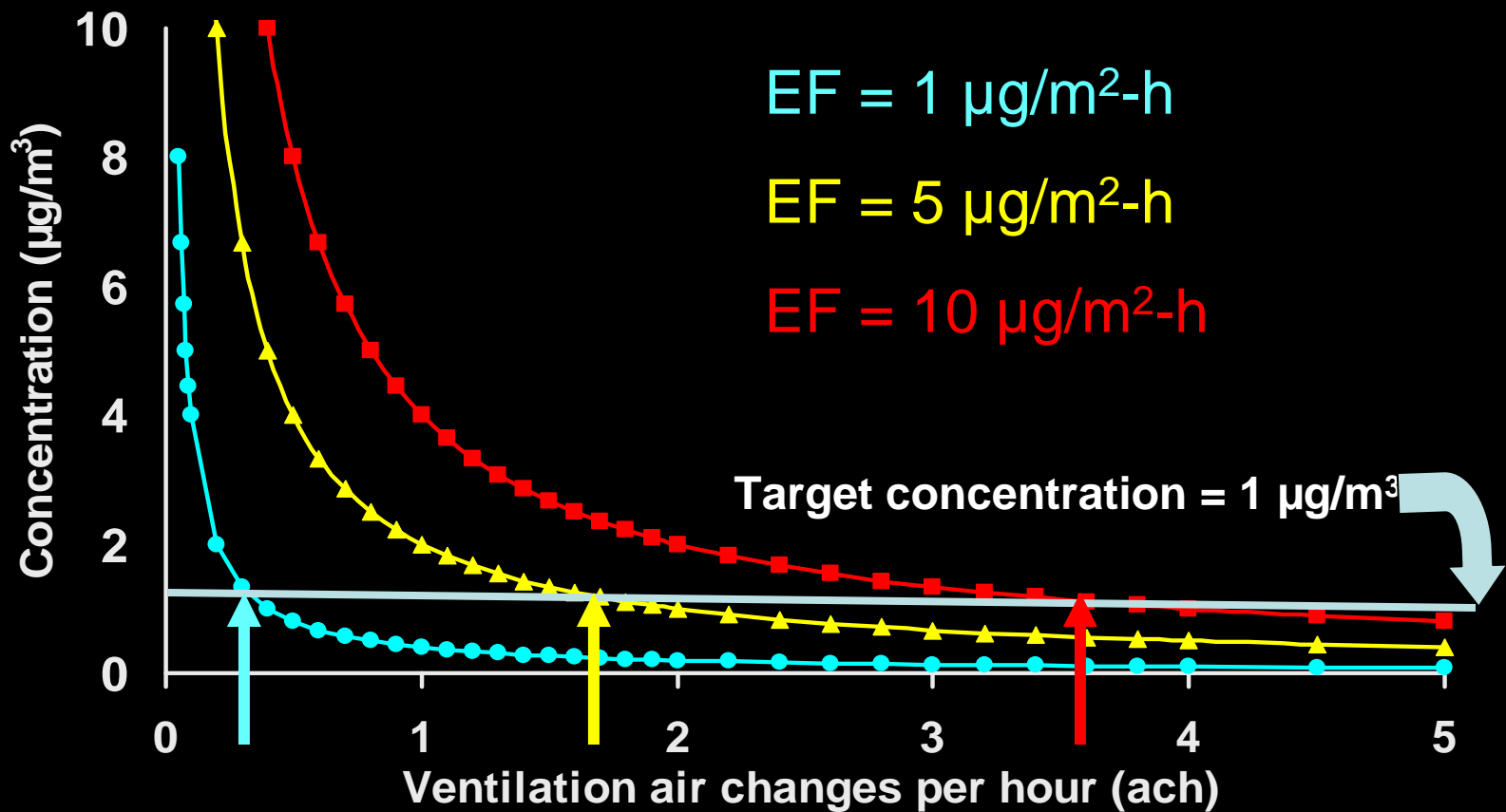


Does decay rate matter?

Faster→ gone after flush out; Slower→ lower peak exposures

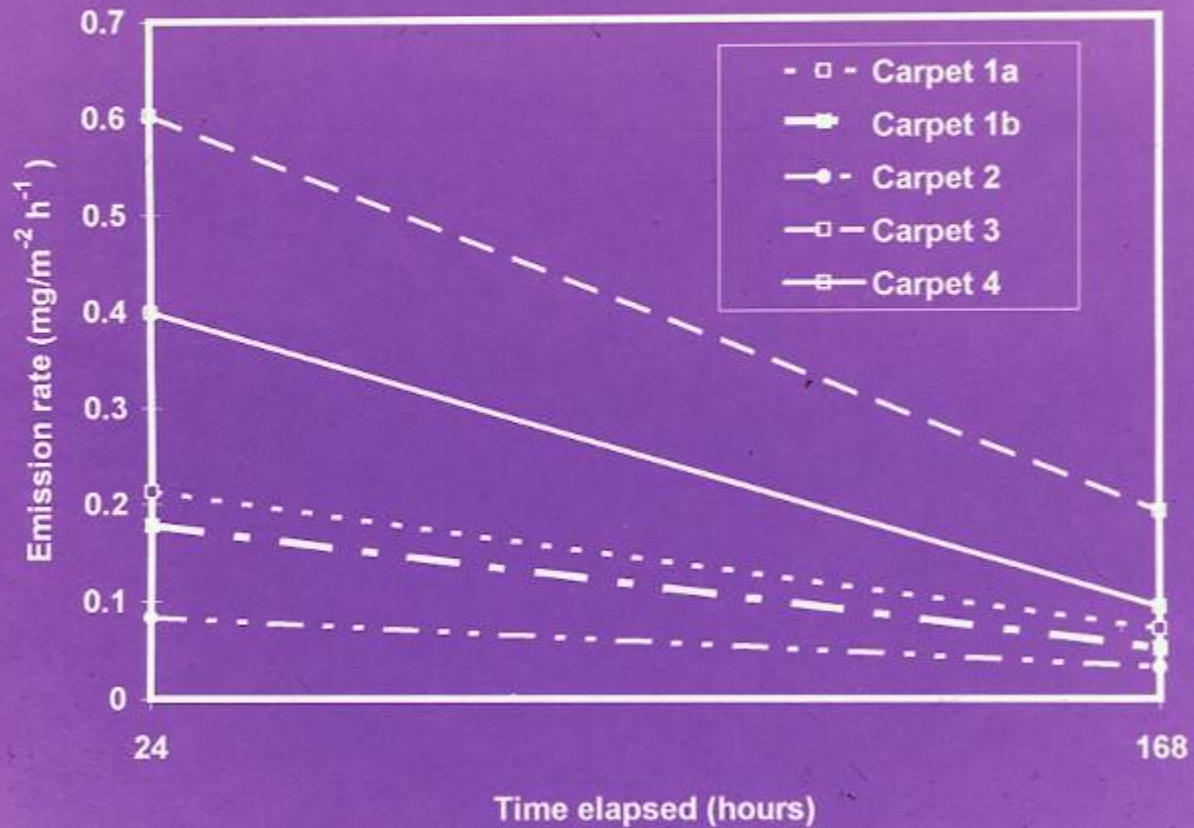
# Healthy and sustainable design

## Ventilation Rate and Source Strength to Reach Target Concentration



# Emission Decay Rates

TVOC Emission Rate Decay:  
Various Carpet Types  
Source: Hodgson et al, 1992



# Mythbusters: Natural is good, Synthetic is bad



## *Natural materials:*

Asbestos (resist fire)

Linseed oil (protect wood, linoleum)

Sand (arsenic)

Lead (preserve paint)

Mercury ( “ “ )

Formaldehyde (wood)

# So What Is a Green Material?

## Like most things in indoor air – It Depends!

- Depends on your goals – human and / or env'l health
- Depends on your criteria – Indoor Air, Sustainability, Climate Change
- Depends on your context – building, location, client
- Depends on your metrics – screening, rigorous, complete
- Depends on your measurements – precision, accuracy
- Depends on your client or project

Thank you for  
your attention

Hal Levin, RHP

