Electrify Your Health!

How Public Health Research Can (and Should) Influence Your Buildings
Learning Objectives

• **Identify** top health concerns in buildings through recent public health research

• **Understand** the relationship between energy performance and health

• **Describe** how going all-electric can improve health in buildings

• **Recognize** resources that are available to promote the design of healthy buildings
How do buildings impact human health?

“We shape our buildings, and afterwards our buildings shape us”
-Winston Churchill

Lauren Hildebrand, Steven Winter Associates, Inc. Sustainability Director
Why I Care
Why YOU Should Care

90% Time we spend indoors
75% Deaths caused by chronic disease, up from 13% in 1800
85% Of the 82,000 chemicals in use lacking available health data

Today’s kids are the first generation expected to have shorter life expectancy than their parents

Source: Fitwel Ambassadors Training Video 2017
What determines health outcomes?

- Genetics/biology: >5%
- Lifestyle/behavior: ≈20%
- Medical care: ≈20%
- Physical & social environment: ≈55%

It’s not your genetic code... it’s your zip code!

Source: https://www.cdc.gov/nchhstp/socialdeterminants/faq.html
By midmorning, the smell of hot peanut oil dissipated and inside the tightly sealed laboratory known as Building 51F, a pink hamburger sizzled in a pan over a raging gas flame. Overhead, fans whirred, whisking caustic smoke up through a metallic esophagus of ductwork.

Woody Delp, 49, a longhaired engineer in glasses — the Willie Nelson of HVAC — supervised the green bean and hamburger experiments. He sat at a computer inside a kitchen simulator, rows upon rows of numeric data appearing on...
EPA: Human Health is affected by...

- **Environmental Tobacco Smoke**
  40,000 deaths/year just secondhand

- **Biological contaminants**
  mold, pollen, dander, bacteria, viruses

- **Combustion byproducts**
  Effective kitchen exhaust?

- **Household products/practices**
  Harder to clean surfaces = more chemicals

Source: EPA, CDC and others
cont’d: Human Health is affected by...

- Toxic materials
  Living Building Institute resource

- Radon
  22,000 deaths/yr in US

- Safety and security
  Creative solutions

- Diet & Exercise
  Encourage movement, health

Source: EPA, CDC and others
Reasons for Hope:
We know more now than ever!
Five Ways Electrification Improves Human Health

1. It’s Cleaner
   • Improved Air Quality

2. It’s More Comfortable
   • Moisture/Temp/Humidity Control

3. It’s Quieter
   • Improved Acoustics

4. It’s Safer
   • Lower CO & Fire risk

5. BONUS: It’s More Cost Effective!
   • Energy & Health ROI
1. It’s Cleaner
Pollutants (Indoor, Outdoor, Both)

- Particulate matter (PM10, PM2.5, Ultrafine particles, Metals, Acids, Condensed organics)
- Nitrogen dioxide (NO2)
- Ozone
- Carbon monoxide (CO)
- Radon
- Pests. Pets. Kids?
- Mold and dampness
- Allergens in air and dust
- Gas-phase organics (VOC) (Formaldehyde, Other aldehydes, Benzene, Acrolein, Organic acids, Semi-volatile organics (SVOC))
- Bioeffluents including CO2
Pollution Is Destroying Our Health!

• 9 out of 10 people now breathe polluted air

• 93% of children <15 years old (=1.8 BILLION) breathe toxic air

• Air pollution kills 7 million people every year

• 1/3 of deaths from stroke, lung cancer and heart disease are due to air pollution

Source: World Health Organization
Fossil Fuel Pollution Impacts Our:

- **Respiratory system:**
  - Lung Cancer - leading cause of cancer in the U.S.
  - COPD - 3rd leading cause of death
  - Asthma

- **Circulatory system:**
  - Coronary heart disease - leading cause of death in the U.S.

- **Nervous system:**
  - Strokes
  - Loss of intellectual capacity from mercury exposure poisoning

Source: American Council for an Energy Efficient Economy and by the Physicians for Social Responsibility
Especially in Kitchens...

- 60% of homes that cook at least once a week with a gas stove can reach pollutant levels that would be illegal if found outdoors. That equates to:
  - 12 million Californians routinely exposed to nitrogen dioxide levels that exceed federal outdoor standards
  - 10 million exposed to formaldehyde exceeding federal standards
  - 1.7 million exposed to carbon monoxide exceeding ambient air standards in a typical week in winter.

Source: LBNL Berkeley Lab
Pollution Makes you Dumber

- 95% of the global population is breathing unsafe air.

- Study found that high pollution levels led to significant drops in test scores in language and arithmetic.

- Equivalent to having lost one year of education.

Source: Proceedings of the National Academy of Sciences
Combustion Byproducts – Kitchen Exhaust

- Poorly vented appliances release toxic fumes, CO
- “Room” exhaust is not great (but allowed)... couple with charcoal recirc hood
- Hoods should cover all burners, and be placed as low as practical for capture
- Consider NOISE & CONTROLS for better usability
- 150 cfm is probably plenty
- Start thinking about makeup air in tight homes
Kitchen Exhaust, Good to Best

- Ducted kitchen exhaust
- Ducted range hood
- Range hood placed for effective capture
- Effective range hood < 2 sone and > 200
- All that interlocked with cooktop or sensors
- ELECTRIC
Bring in (and Treat) Fresh Air

The Solution to Pollution is Dilution!

- Balanced ventilation strongly preferred. Heat Recovery/Energy Recovery even better!
- Fresh air is expensive… distribute it wisely
- Always check the controls at installation. If the contractor can’t explain it to you, he can’t explain it to the building manager either.
- Shut-offs are important (skunks, fire, asphalt)
- Test/Balance/Test/Maintain
Don’t Forget the Filters!

- MERV 13 is the lowest that can meaningfully capture PM 2.5
- Pleated, 2” or 4” thick
- Charged/”Electret” can help with pressure drop
- Filter Grille design… do not allow bypass, leave access
- Grille/filter sizing… likely larger than you think to keep pressure drop in check
- Filters must be changed often!
2. It’s More Comfortable
Humidity/Temp/Moisture Control

- In addition to proper air sealing & water management, all electric buildings can be:
  - Warmer
  - Dryer
  - Better Ventilated
    - Lowers risk of illnesses and mold growth
- Replace gas-fired domestic hot water and space heaters with electric DHW and heat pump
- Independently control temperature in each room – decentralized
3. It’s Quieter
Manage Noise, Manage Stress

Heat Pumps Can be Quieter

- Indoor air handler part of a heat pump is generally quieter than single-stage gas furnaces. Hydronic type heaters function in near silence (if installed correctly).
- Steam radiators – eliminate constant “clang”

Other Recommendations:

- Use air sealing and sound attenuation to separate multi-dwelling units
- Choose fans based on sone ratings
- Remote-mount fans
- Study ‘free area’ for grilles and louvres to avoid whistling
- Test background sound!

TARGET LEVELS
20 dB Bedrooms
40 dB Living rooms
4. It’s Safer
Safety: Less Gas, Less Worry

• Less Risk of Carbon Monoxide Poisoning
  • Still recommend CO monitors in all units

• Fire & Explosion Safety
  • Clothes Dryers: check your ductwork
  • Gas Cooktops: it’s a mini fire in your house!
  • DHW: Your chances of an explosion from a gas leak are much greater than electrocution from faulty wiring to your tank.
5. It’s More Cost Effective & Equitable
Leverage the **Value of PEOPLE** in Buildings

**The Value of People**

Based on a typical split of business operating costs, modest gains in staff productivity, through engagement & wellbeing can deliver significant financial benefits.

It’s time to focus on the employee experience.

Companies with Engaged Employees have:

- 37% lower absenteeism
- 10% higher customer satisfaction
- 21% higher productivity
- 65% lower employee turnover

Source: WGBC’s Health, Wellbeing & Productivity in Offices
Our Employees Will Be Happier

Employees are **Happier, Healthier, More Productive** in LEED Green Buildings:

- **93%**: of those who work in LEED buildings are satisfied with their job
- **81%**: enhanced air quality improves their physical health and comfort
- **85%**: access to outdoor views and natural sunlight boosts productivity and happiness
- **79%**: employees opt for a job in a LEED building vs non-LEED building
Our Residents Will Breathe Easier

- 2-yr study of effects of green building on building residents with asthma
- Evaluated ER visits, sleepless nights, days with reported symptoms
- Days with asthma symptoms decreased, 6.9 to 3.4 at 6 months and 2.2 at 12 mos
Good fresh air makes YOU smarter

Source: #THECOGFXSTUDY
In other words... Healthy Buildings = PROFIT

TOTAL BENEFITS DUE TO INVESTMENT IN HPBS

Profit per Employee

- $1.33M Annual Profit Due to Enhanced Productivity
- $1.25M Annual Profit Due to Increased Retention
- $201K Annual Profit Due to Reduced Absenteeism

Profit per Company

- $2.78M or 6.29% Annual Profit Due to Investment in High Performance Buildings

FIGURE 14 (referenced in Section 4.5)
Cumulative financial benefit of HPBs due to enhanced productivity, increased retention, and reduced absenteeism (assuming 150,000 SF space housing 820 employees)
A reminder about Asthma $$$

- People/yr treated for asthma: 15.4 million
- US total annual cost in 2015: $81.9 billion
- Asthma-related mortality cost: $29 billion/year
- Missed work & school days: $3 billion/yr
  - 8.7 million workdays lost
  - 5.2 million school days lost
Health Based Building Incentives

• (NY)SERDA and DOH’s NYS Healthy Homes Pilot
  – Pilot will test a residential “healthy homes” intervention that combines energy efficiency measures, asthma trigger reduction measures, and home injury prevention measures provided to a group of 500 Medicaid member households in several pilot locations throughout the State.

• Enterprise’s Health Begins with Home Initiative
  – $250 million to work over 5 years promoting health as a top priority in affordable housing

• Get More Utility Providers Involved

• Insurance Underwriting
Pick your reason(s)
Studying The Optimal Ventilation for Environmental Indoor Air Quality:

STOVE IAQ

Elizabeth Garland, MD, MS
Department of Environmental Medicine and Public Health
Purpose of the Study

- Multicity collaboration
- Enterprise Green Community Partners
- National Center for Healthy Housing

Determine if ASHRAE 62.2 (2010 or later) in multifamily Green Communities housing is associated with:
- variations in indoor air quality
- general health measures
Study Hypothesis

Multifamily Green Communities housing with ASHRAE-compliant ventilation will have:

- Significantly lower indoor levels of
  - PM$_{2.5}$
  - Formaldehyde
  - NO$_2$
  - CO
  - CO$_2$

- Resulting in better general and respiratory health
Eligibility of Buildings

- Multifamily housing units previously rehabilitated to Green standards within the past 5 years
- Working gas stove
- Open to all people

- National Center for Healthy Housing and Enterprise Green Communities confirm eligibility
Study and Comparison Groups

- **Study group:**
  - ASHRAE-compliant buildings
  - Continuous or intermittent (e.g., 20 minutes/hour) ventilation in each dwelling
  - Exhaust ventilation over stoves

- **Comparison group:**
  - Non-ASHRAE-compliant building
Phases

- Recruitment
- Screening– determine eligibility

- Three phases:
  - Baseline
  - 4 months after baseline
  - 8 months after baseline
Study Methods

- Screen: meet inclusion criteria
- Home Interview
- Health Interview
- Environmental Assessment
- Visual Assessment
- Dwelling performance
Dwelling Performance

- Unit characteristics
- Duct System
- Ventilation Flows
- Pressures
- Microsoft Access

Conducted by independent contractor at baseline
Home Interview

- Questions answered by primary adult
- Contains questions about:
  - Household income
  - Housing conditions
  - Pets
  - Pests
  - Comfort
  - Safety
  - Smoke in the home
Health Interview

- **Respiratory**: Asthma, allergies, nasal

- **Adult**:
  - SF-36, health-related-quality of life
  - smoking
  - stress
  - Medical conditions (e.g., COPD)

- **Child**:
  - SF-12
  - smoking (if age ≥ 12)
  - Medical conditions (e.g., ear infections)

In general, would you say your health is:
1 - Excellent
2 - Very good
3 - Good
4 - Fair
5 - Poor
HEALTH, EQUITY & ETHICS: Strategies For Addressing High GWP & Toxic Chemicals In Insulation
Mission

To advance human and environmental health by improving hazardous chemical transparency and inspiring product innovation.
Health     Equity     Ethics

Chemicals Of Concern

• Persistent, Bioaccumulative Toxicants (PBTs)
• Halogenated flame retardants
• Formaldehyde-based binders
• Isocyanates
• High Global Warming Potential
Health Impacts

• Cancer
• Reproductive Capacity
• Brain Development
• Asthma & Respiratory Disease
• Climate Change
Health     Equity     Ethics

**Impacted Communities**

- Building Occupants
- Construction Workers
- Manufacturing Workers
- Fenceline Communities
- Poor & People of Color
- Global Environment
Centering Equity in the Sustainable Building Sector

“Whether it’s as policymakers, advocates, architects, project managers, contractors, or even in the construction workforce, the most impacted communities are underrepresented in the design, construction, and occupancy of sustainable, regenerative, healthy buildings.”
Strategies For Chemical Hazards

Healthybuilding.net
In Depth Analysis

Multi-factor Product Evaluation
# Building Insulation - Recommended and Other Materials, Cost, Performance, Transparency, and Installation Considerations

<table>
<thead>
<tr>
<th>Health-Based Ranking</th>
<th>Insulation Type</th>
<th>R-Value per Inch*</th>
<th>Relative Installed Cost per R-Value**</th>
<th>Special Installation Equipment Required</th>
<th>Vapor Retarder*</th>
<th>Air Barrier Material**</th>
<th>Level of Transparency on Chemical Content***</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Green is best; red is worst)</td>
<td>Expanded Cork Board</td>
<td>3.6-4.2</td>
<td>$$$$</td>
<td>no</td>
<td>Class III</td>
<td>Information not available</td>
<td></td>
</tr>
</tbody>
</table>

**Blown-In Fiber Glass**

<table>
<thead>
<tr>
<th>Insulation Type</th>
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<th>Special Installation Equipment Required</th>
<th>Vapor Retarder*</th>
<th>Air Barrier Material**</th>
<th>Level of Transparency on Chemical Content***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose-Fill Fiber Glass</td>
<td>2.2-3.1</td>
<td>$</td>
<td>yes</td>
<td>Vapor permeable</td>
<td>Not an air barrier</td>
<td></td>
</tr>
<tr>
<td>Dense-Pack Fiber Glass</td>
<td>3.7-4.6</td>
<td>$$</td>
<td>yes</td>
<td>Vapor permeable</td>
<td>Not an air barrier but does reduce airflow</td>
<td></td>
</tr>
<tr>
<td>Spray-Applied Fiber Glass</td>
<td>4.0-4.3</td>
<td>$$</td>
<td>yes</td>
<td>Vapor permeable</td>
<td>Not an air barrier but does reduce airflow</td>
<td></td>
</tr>
<tr>
<td>Fiber Glass Batts/Blankets (Kraft-Faced and Unfaced)</td>
<td>2.9-4.3</td>
<td>$</td>
<td>no</td>
<td>Kraft-faced: Class II; Unfaced: Vapor permeable</td>
<td>Not an air barrier</td>
<td></td>
</tr>
<tr>
<td>Fiber Glass Batts/Blankets (PSK or FSK-Faced, Basement Wall Insulation)</td>
<td>Duct wrap: 2.7-3.2; Basement wall insulation: 3.0-3.5</td>
<td>$$</td>
<td>no</td>
<td>Class I (except basement wall insulation where facing is perforated to allow for moisture transfer)</td>
<td>Facing may be an air barrier material</td>
<td></td>
</tr>
<tr>
<td>Cellulose/Cotton Batts and Blankets (Unfaced)</td>
<td>3.5-4.0</td>
<td>$$-$$$</td>
<td>no</td>
<td>Vapor permeable</td>
<td>Not an air barrier</td>
<td></td>
</tr>
</tbody>
</table>
• Recommendations by Product Category
• Spec Language
• Submittal Inserts
In Summary

**INSULATION — HEALTHIER MATERIAL RECOMMENDATIONS**

- Expanded cork board is top ranked
- Prefer fiber glass and cellulose insulation
- Avoid products with formaldehyde-based binders
- If board insulation is required, prefer rigid mineral wool insulation
- Avoid foam insulation, whether board or spray-applied
- Use mechanical installation methods
In Summary

**AIR SEALING — HEALTHIER MATERIAL RECOMMENDATIONS**

- Prefer caulk-type sealants over spray foam sealants
- Prefer foam sealing products that are not reacted on site
- Avoid phthalate plasticizers
- Prefer acrylic-based sealants with very low levels of VOCs
- Prefer foil-backed butyl tape for HVAC sealing
- Avoid products that are marketed as being antimicrobial
Thank you!
Any Questions?

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