

HOME BITTERSWEET HOME: HOW DEFICIENT INDOOR AIR QUALITY IS THREATENING WHERE WE LIVE

A guide to understanding how indoor air contaminants adversely affect all homes, and what can be done

By Nick Agopian

Deficient Indoor Air Quality Threatens all Homes

As construction methodologies have progressed, more and more homes are becoming increasingly air-sealed in order to reduce air leakage, improve energy efficiency, reduce heating and cooling costs, further occupant comfort and strengthen structural durability. However, without the proper amount of fresh outdoor air replacing stale indoor air, an unintended consequence is deficient indoor air quality (IAQ). This is a serious, yet often unnoticed, threat to occupant health, cognitive function and general well-being.

Deficient IAQ inside homes is a threat that needs to be addressed, especially considering these facts:

- According to the Environmental Protection Agency (EPA), people spend about 90 percent of their time indoors (the elderly 95 percent), and about 65 percent of this time is spent inside homes.¹
- Indoor air levels of many pollutants may be two to five times, and occasionally more than 100 times, higher than outdoor levels.²
- The EPA ranks indoor air pollution among the top-five environmental risks to public health.³
- The EPA estimates that Americans receive 72 percent of their chemical exposure at home.⁴
- The World Health Organization (WHO) estimates that 4.3 million people a year die from household air pollution.⁵
- The WHO estimates that 30 percent of all new or renovated buildings, including homes, suffer from deficient IAQ.⁶
- The U.S. Consumer Product Safety Commission states that older homes are particularly vulnerable to asbestos, which is most commonly found in pipe and furnace insulation materials, asbestos shingles, millboard, textured paints, other coating materials and floor tiles.⁷



Deficient IAQ threatens all homes
Image courtesy of Environmental Health Perspectives (EHP)

Causes of Deficient IAQ

When stale indoor air isn't sufficiently exhausted out, a complex array of internally generated contaminants, such as toxins, vapors, gases, chemicals and other Volatile Organic Compounds (VOCs), can build up and diminish IAQ. Contaminants are introduced in many ways, but the primary means is by being off-gassed from a variety of sources inside a home. Following is a chart outlining indoor air contaminants, their sources and their adverse effects on home occupants:

¹ "Why Indoor Air Quality is Important to Schools," U.S. Environmental Protection Agency (EPA), <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>.

² "Why Indoor Air Quality is Important to Schools," U.S. Environmental Protection Agency (EPA), <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>.

³ "Why Indoor Air Quality is Important to Schools," U.S. Environmental Protection Agency (EPA), <https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools>.

⁴ "Indoor Air Quality," UL Environment's GREENGUARD Certification, http://greenguard.org/en/consumers/consumers_iaq.aspx.

⁵ "Household air pollution and health," World Health Organization, February 2016, <http://www.who.int/mediacentre/factsheets/fs292/en/>.

⁶ "The Inside Story: A Guide to Indoor Air Quality," U.S. Consumer Product Safety Commission (CPSC), <http://www.cpsc.gov/en/Safety-Education/Safety-Guides/Home/The-Inside-Story-A-Guide-to-Indoor-Air-Quality/>.

⁷ "The Inside Story: A Guide to Indoor Air Quality," U.S. Consumer Product Safety Commission (CPSC), <http://www.cpsc.gov/en/Safety-Education/Safety-Guides/Home/The-Inside-Story-A-Guide-to-Indoor-Air-Quality/>.

INDOOR AIR CONTAMINANTS, SOURCES AND ADVERSE EFFECTS

INDOOR AIR CONTAMINANTS	SOURCES	ADVERSE EFFECTS
Humidity	Exhaled breath, water sources (faucets, showers, leaks)	Aggravated allergies and asthma
Carbon Dioxide	Exhaled breath	Headaches, fatigue, drowsiness, eye and throat irritations; impairs cognitive function and decision-making
Formaldehyde	Off-gassed from adhesives, fabric treatments, stains, varnishes	Irritations to respiratory system, eyes, nose and throat; known carcinogen potentially causing cancer
Other Volatile Organic Compounds (VOCs), toxic gases and vapors	Off-gassed from furniture, carpets, paints, cleaners, solvents, glues, other building materials	Headaches, fatigue; irritations to eyes, nose, throat and skin
Odors	Bathrooms, kitchens, pets, occupants (perfume, soap/shampoo residue, detergent used to wash clothing, general odors)	Headaches, dizziness, nausea
Bioeffluents	Human metabolic process	Headaches, fatigue, drowsiness, eye and throat irritations
Molds, bacteria, fungi, microbial contaminants	Stagnant water, drains, condensate pans, damp areas	Aggravated allergies and asthma
Radon	Uranium decaying in the soil	Cell damage, potentially lung cancer
Dust mites	Carpets, fabric, foam cushions	Aggravated allergies and asthma
Phthalates	Off-gassed from adhesives, vinyl flooring, wood finishes, plastic plumbing pipes, other building materials	Obesity, reproductive problems, potentially cancer
Carbon Monoxide	Exhausted from gas heating systems, gas stoves, gas hot-water heaters, cigarette smoke, cars	Headaches, fatigue, dizziness
Tobacco smoke	People smoking inside or near a home (first-hand, second-hand and third-hand)	Headaches, dizziness; known carcinogen potentially causing cancer
Wood-fire smoke	Fireplaces, unvented appliances	Respiratory irritations
Ozone	Off-gassed from home-office equipment, electric motors, electrostatic air cleaners	Chest pain, asthma, respiratory irritations
Lead	Pipes, paint	Problems with central nervous system, kidney and blood cells; impairment of mental and physical development; high levels can cause convulsions, comas and death
Asbestos	Insulation	Long-term risk of chest and abdominal cancers and lung diseases

Sources: U.S. Environmental Protection Agency (EPA) and Canadian Centre for Occupational Health and Safety (CCOHS)⁸

Adverse Effects of Deficient IAQ

Deficient IAQ has numerous [adverse effects on the health and cognitive function](#) of home occupants, and below are some examples:

- Health problems:** Deficient IAQ has many adverse health effects, including acute allergies, headaches, coughs, asthma, skin irritations and breathing difficulties, as well as chronic illnesses such as cancer, liver disease, kidney damage and nervous-system failure.
- Cognitive impairment:** It also causes cognitive impairment, as shown in studies by the Harvard School of Public Health and the Lawrence Berkeley National Laboratory in which Carbon Dioxide (CO₂) – an indoor air contaminant – [negatively impacted thinking and decision-making](#) at levels commonly found inside homes.⁹
- Children are at greatest risk:** Children are more vulnerable than adults to the adverse effects of breathing in indoor air contaminants. Due to their physiology, children inhale more pollutants per kilogram of body weight than do adults and because children's airways are narrower, irritation means greater obstruction, according to the WHO.¹⁰ What's more, children's immune systems are less developed and provide a weaker defense against contaminants.
- Problems magnified while asleep:** Where home occupants are particularly vulnerable to the adverse effects of deficient IAQ is while asleep. This is the case because during sleep, people breathe more deeply thus allowing a greater amount of contaminants to enter into the body. The results are aggravated asthma and allergies, stuffy noses,

⁸ Indoor air contaminants sourced from: "An Introduction to Indoor Air Quality," U.S. Environmental Protection Agency (EPA), <http://www.epa.gov/indoor-air-quality-iaq/introduction-indoor-air-quality> and "Indoor Air Quality - General," Canadian Centre for Occupational Health and Safety (CCOHS), http://www.ccohs.ca/oshanswers/chemicals/iaq_intro.html

⁹ Joe Romm, "Exclusive: Elevated CO₂ Levels Directly Affect Human Cognition, New Harvard Study Shows," Climate Progress, October 26, 2015, <http://thinkprogress.org/climate/2015/10/26/3714853/carbon-dioxide-impair-brain/>.

¹⁰ "Children's Health and the Environment," World Health Organization (WHO), July 2008, http://www.who.int/ceh/capacity/Indoor_Air_Pollution.pdf.

headaches, scratchy throats, coughs, sleep interruptions and general sickness. To make matters worse, a constant stream of contaminants is off-gassed from the foams, plastics and flame-retardants found in most new beds and mattresses.

How to Know if Your Home Suffers from Deficient IAQ

It's clear that deficient IAQ is a serious problem, but how do you know if your home is affected or vulnerable, especially since the majority of indoor air contaminants are invisible? The key is having a clear understanding of what constitutes indoor air contaminants, as well as where they are sourced from inside a home. With this knowledge, you can then do a check around the house to see if any vulnerabilities exist.

Along these lines, Oregon State University compiled a comprehensive and useful [Home Indoor Air Quality Checklist](#), which is a guide to help determine the general status of IAQ in your home. The more questions from the checklist that you answer in the affirmative, the greater the chance your home suffers from deficient IAQ.¹¹

- **Sources of indoor air contaminants:**
 - Do any household members smoke?
 - Do you have any unvented gas appliances?
 - Do any furry pets live indoors?
 - Are insecticides or pesticides used indoors?
 - Are cars parked in an attached enclosed garage?
 - Are any of the following hobbies conducted indoors: woodworking, jewelry making, pottery or model building?
 - Is part of your living area below ground?
 - Is your home insulated with urea-formaldehyde or asbestos?
 - Do burner flames on gas heating or cooking appliances appear yellow instead of blue?
 - Do you regularly use a fireplace or woodstove?
- **Strength of indoor air contaminants:**
 - Are there unusual and noticeable odors?
 - Is the humidity level unusually high or is moisture noticeable on windows or other surfaces?
 - Are there lingering cooking odors?
 - Does the air seem stuffy?
 - Is the house temperature unusually warm or cold?
 - Are there dirty heating and air conditioning units?
 - Is there a noticeable lack of air movement?
 - Is dust on the furniture noticeable?
 - Is dust or dirt staining walls, ceilings, furniture or draperies?
 - Have you recently installed new furniture or carpeting or are you using new household products?
- **High-risk household members:**
 - Are any household members less than four years old or more than 60 years old?
 - Is anyone normally confined to the house more than 12 hours per day?

- Does anyone suffer from COPD, asthma, bronchitis, allergies or heart problems?

Ventilation is the Most Effective Way to Enhance IAQ in Homes

What's the best way to provide cleaner and healthier air inside homes? The answer is more and better ventilation. As long as enough controlled fresh outdoor air is coming in and stale indoor air is exhausted out, homes will enjoy high-quality indoor air. The American Lung Association supports this notion and states that proper ventilation is essential for keeping the air fresh and healthy inside homes.¹²

Ventilation is so critical for ensuring acceptable IAQ for homes that the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) created Standard 62.2, which sets ventilation requirements for removing indoor air contaminants from homes. The goal of the standard is to "design HVAC and other systems to work together to effectively ventilate homes and minimize sources of indoor pollution."¹³

Bath Fans Are Not Optimal for Enhancing IAQ in Homes

Not all ventilation systems are created equal. For example, a popular home-ventilation option is bath fans since they're relatively inexpensive and fairly easy to install. Unfortunately though, bath fans only remove the bare minimum of indoor air contaminants, they can bring in outdoor contaminants since they lack filters and they waste considerable amounts of energy. In fact, when you add up all of the money spent powering and maintaining a bath fan over its lifetime, you'll be far into the red.

Other forms of home ventilation systems suffer from the same problems as bath fans – they're inefficient, expend massive amounts of energy and are unreliable. Additionally, traditional ventilation systems need ongoing maintenance, which adds to the overall cost of operation. That said, extra costs and inefficiency don't have to be the norm when ventilating homes, and can be avoided.

Energy Recovery Ventilation Enhances IAQ Energy-Efficiently & Cost-Effectively

Energy recovery ventilation (ERV) takes the effectiveness of ventilation one step further by enhancing IAQ both energy-efficiently and cost-effectively. This ventilation technology optimizes energy efficiency by preconditioning the outside air coming in with the otherwise-wasted heat and humidity of the exhaust air going out. The technology is so effective that the EPA supports its use and states, "Energy recovery ventilation systems provide excellent opportunities for saving energy, controlling humidity and providing sufficient outside air to promote IAQ."¹⁴

Below are the benefits of an ERV system for home ventilation:

- Energy efficiency is optimized.
- Heating and cooling [HVAC loads are reduced](#).
- [Significant annual energy savings](#) are generated over the long-term (a typical ERV system can save up to 40 percent in HVAC operating costs).
- Cleaner and healthier indoor air is realized since indoor air contaminants are removed by exhausting stale indoor air, while outdoor contaminants are prevented from entering through filtration.
- HVAC equipment downsizing results in additional lower costs.
- Sustainability is strengthened due to minimized carbon footprints.

¹¹ "Home Indoor Air Quality Checklist," Oregon State University, <http://extension.oregonstate.edu/fcd/vprograms/fcelessons/fcepdffiles/FCD2-002.pdf>.

¹² "Ventilation: How Buildings Breathe," American Lung Association, <http://www.lung.org/our-initiatives/healthy-air/indoor/at-home/ventilation-buildings-breathe.html>.

¹³ "10 Tips For Home Indoor Air Quality," ASHRAE, <https://www.ashrae.org/resources--publications/free-resources/10-tips-for-home-indoor-air-quality>

¹⁴ "Indoor Air Quality and Energy Efficiency," U.S. Environmental Protection Agency (EPA), <https://www.epa.gov/indoor-air-quality-iaq/indoor-air-quality-and-energy-efficiency>.

Additionally, energy recovery ventilation is the perfect complement to [increasingly air-sealed homes](#). Air-sealing methodologies increase energy efficiency by reducing air leaks, but this can lead to deficient IAQ. With energy recovery ventilation, the energy efficiency realized through air sealing is maintained and cleaner and healthier indoor air is provided. What's more, energy recovery ventilation meets the ASHRAE ventilation and energy standards, thus enabling any home to become a [high-performance residence](#).

RenewAire is the Best Choice for Energy Recovery Ventilation

We now know that energy recovery ventilation is the most effective option for homes to enhance IAQ, but not all ERV systems are at the same level. The best option is [RenewAire's high-efficiency, enthalpic-core, static-plate ERV systems](#). When compared to other ERV options, here are the reasons why RenewAire makes the most sense.

- RenewAire was the first company to manufacture static-core ERV technology in North America over 30 years ago.
- Static cores are the most reliable form of ERV technology in the industry and hardly ever break down.
- Due to unparalleled reliability and efficiency, annual energy savings are amplified.
- The systems are built to last for over 20 years, and deliver significant energy savings every year over their lifetime.
- Due to significant energy savings, the payback is period short.
- All climates are supported, from the coldest, driest conditions in Alaska, to the hottest, most humid extremes in Miami.
- Exhaust and fresh outdoor airstreams are kept completely separate to prevent airstream cross-contamination.
- No condensate pans or drains are used, and there's no need to defrost.

- RenewAire offers an industry-leading 10-year warranty on the static core, and the company's warranty-claim track record is the lowest in the industry.
- RenewAire units are designed with flexibility in mind to support a wide array of home sizes, types and installation constraints.
- System installation and use is easy and straightforward.
- Maintenance is simple and minimal.
- All units are competitively priced.
- Temperatures and humidity are moderated to maintain a comfortable indoor environment.

In Sum

Deficient IAQ is threatening all homes and has many adverse effects on occupants, including a myriad of health problems, as well as cognitive impairment. And the situation is only getting worse as homes are becoming increasingly air-sealed, thus locking in a complex array of indoor air contaminants. The most effective way to enhance IAQ in homes is with more and better ventilation, and by utilizing ERV technology, energy efficiency will be optimized, heating and cooling HVAC loads will be reduced, significant long-term savings will be generated and cleaner and healthier indoor air will be provided.

Nick Agopian is Vice President of Sales and Marketing at [RenewAire](#), a pioneer in enhancing indoor air quality in commercial and residential buildings of all sizes through high-efficiency, enthalpic-core, static-plate Energy Recovery Ventilation (ERV) systems. For more information, visit: www.renewaire.com.