SEDAC Energy Smart Tips

Energy Code: Indoor Air Quality

September 2018

ENERGY EFFICIENCY = POOR INDOOR AIR QUALITY?

Americans spend most of their time indoors where they can be exposed to pollutants and mold. Indoor air often contains much higher concentrations of pollutants than outdoor air. Indoor air pollution costs Americans tens of billions of dollars each year in health care costs, sick days, and decreased productivity.[1]

There's a common myth that energy efficient buildings do not promote good indoor air quality. Do the strategies that make homes and buildings more energy efficient compromise air quality? It depends.

One primary strategy to improve energy efficiency is to tighten the building envelope. A tight building envelope substantially reduces heating and cooling costs by permitting less hot or cool air to escape or enter the building. A tighter envelope can *improve* air quality by preventing humid air and pollutants from entering the conditioned space. However, unless the building is properly ventilated, a tighter building envelope traps pollutants inside, leading to poor indoor air quality.

It's important to note that homes and buildings built to current industry standards are both energy efficient *and* have good indoor air quality. By following the requirements of the Illinois Energy Conservation Code, you can build tight *and* ventilate right.

"Build tight, ventilate right" by complying with the Illinois Energy Conservation Code.

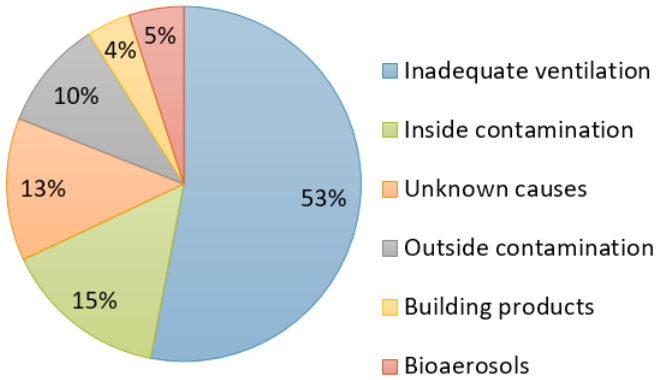
CAUSES OF INDOOR AIR POLLUTION

Flaws in the building envelope and heating, ventilation, and air conditioning (HVAC) systems allow pollutants into the conditioned indoor air. Pollutants such as pesticides, formaldehydes, carbon monoxide, radon, asbestos, and tobacco smoke can come from inside the building or be brought into the building from outside.

Drafty buildings allow pollutants to easily flow into and out of the indoor environment. Buildings with tight envelopes but poor ventilation are even worse because pollutants become trapped inside the building. The more tight a building envelope is, the more important ventilation becomes.

Uncontrolled moisture and excessive humidity in a residential and commercial buildings also compromise indoor air quality. A building envelope that is not tightly sealed can allow excessive humidity in a facility, leading to moisture problems. Biological contaminants such as mold and mildew spread rapidly and can have serious health effects. Mold and mildew are often found in damp or wet areas, such as home basements and bathrooms, and humidification systems, cooling towers, and drain pans in facilities. This is particularly a problem in Illinois during the hot, humid summers.

Figure 1: Causes of Indoor Air Quality Problems



Source: National Institute of Occupational Safety and Health

1 See EPA, Indoor Air Quality. https://www.epa.gov/indoor-air-quality-iaq

THE PROBLEM: POOR INDOOR AIR QUALITY

Short-term health effects
Building occupants who are exposed to poor indoor air quality often experience short-term health effects, such as:

- Eye, nose, and throat irritation
- Headaches
- Mental fatigue
- Skin irritation
- Dizziness
- Nausea

These symptoms may disappear once the occupant has left the building.

Long-term health effects
Some occupants may not experience health effects until years after the initial exposure. Others experience long-term health effects from extended exposure to pollutants or mold. These effects include respiratory disease, heart disease, and cancer.

Long-term effects are especially severe for people with asthma or allergies. In many cases, asthma is associated with indoor air pollution (e.g., mold spores, pollutants, pests). Given that 1 in 13 children are diagnosed with asthma, ensuring good indoor air quality is a major health priority.

THE SOLUTION: ENERGY CODE COMPLIANCE

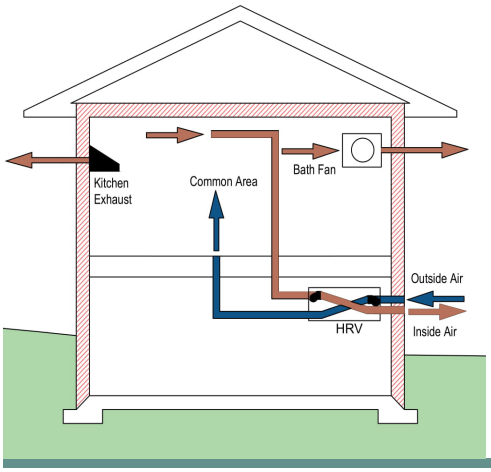
Energy Conservation Code requirements ensure that homes and buildings are both energy efficient and have good air quality to prevent health problems.

1. Air sealing and thermal envelope requirements help prevent mold, mildew, and dust mites.
2. Slab edge insulation requirements prevent mold from growing in carpeted basements by reducing condensation.
3. Whole-building ventilation requirements ensure that adequate fresh air is provided for occupants.
4. The HVAC system sizing requirement helps prevent humidity issues as properly sized cooling coils will remove more moisture from the air.
5. Air barrier requirements prevent air from carrying and depositing moisture into wall cavities.
6. Rim joist sealing requirements protect against condensation along the rim joists, which often leads to rot and mold.
7. Window requirements reduce condensation on glass surfaces, which can damage nearby walls, celings, and floor materials over time.
8. Ceiling insulation requirements prevent ice dams (thick ridges of ice that build up along the eaves) which cause water to build up and leak into the house.

RESIDENTIAL CODE REQUIREMENTS

The current Illinois Energy Code is based on the 2015 IECC, although the code will be updated to the 2018 IECC in March of 2019. The requirements discussed in this Energy Smart Tip are based on the 2018 IECC and are subject to change, based on Illinois Amendments.

Figure 2: Whole House Mechanical Ventilation



R402.1 Building Thermal Envelope
The Code specifies insulation requirements for the ceiling, wall, fenestration, floor, basement wall, slab-edge and crawl space components of the building envelope. Walls must also meet vapor retarder requirements.

R402.4 Air Leakage
The Code has extensive mandatory requirements to control air leakage in buildings and residences. This includes:

- A continuous air barrier in the building envelope and sealing of breaks and joints
- Air barrier materials with a very low air-leakage rate.
- Infiltration rate of no more than 0.3 cfm per square foot for windows, skylights, and sliding doors.
- Testing to verify that the home has an air leakage rate not exceeding 4 air changes per hour (per the Illinois Amendments).

R403.3 Ducts
Ducts and pipes must also be insulated and sealed. The code specifies leakage rates and requires mandatory duct testing. Insulating and sealing duct work minimizes heat loss and prevents unconditioned air from infiltrating negatively pressurized ducts and conditioned air from leaking at unwanted locations.

R403.6 Mechanical ventilation
Whole-house mechanical ventilation is required. Mandatory requirements state that "outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating."

Funding provided in whole or in part by the Illinois EPA Office of Energy. This material is based upon work supported by the U.S. Department of Energy, under the State Energy Program Award Number DE-EE0008646.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

COMMERCIAL CODE REQUIREMENTS

C402.1 Building Thermal Envelope: Insulation
The code specifies minimum insulation requirements for the ceiling, wall, floor, basement wall, slab-edge and crawl space wall components of the building envelope. Insulation must be *continuous* in many locations, meaning that it extends across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior and is integral to any opaque surface of the building envelope. Building designers are encouraged to *exceed* the minimum insulation requirements to further reduce heating and cooling loads and increase comfort.

C402.4 Fenestration
Fenestration requirements specify U-factor and Solar Heat Gain Coefficient values for all window products. U-factor measures how well a product prevents heat from escaping, and SHGC measures how well a product blocks heat caused by sunlight. Following these requirements can reduce condensation and utility costs.

C402.5 Air Leakage
The Code has extensive mandatory requirements to control air leakage in buildings and residences. These include:

- Continuous air barrier for all building envelope assembles.
- Joints and seams must be sealed
- Penetrations must be caulked and gasketed and allow for expansion, contraction, and mechanical vibration.
- Fenestration must not exceed maximum air leakage rates found in the Code.
- Air barrier materials must have very low air-leakage rates.

Figure 3: Blower Door Testing is required by R402.4.1.2 to ensure appropriate air leakage rates in residential buildings.

C403.11 Duct and plenum insulation and sealing
Ducts and plenums located in unconditioned spaces must also be insulated and sealed to meet the appropriate minimum insulation requirements. The code specifies leakage rates and requires mandatory duct testing.

C403.2.2 Ventilation
Whole-building mechanical ventilation or natural ventilation is required, and ventilation rates are set in chapter 4 of the International Mechanical Code. For mechanical ventilation, the system must have the capability of reducing the outdoor air supply to the minimum required rate.

ENERGY EFFICIENT VENTILATION

Indoor air quality is important! However, providing conditioned fresh air is expensive from an energy perspective. There are two keys to efficient ventilation:

1. Recover energy from ventilation exhaust, using one or more of these strategies:

- dedicated outdoor air systems with energy recovery
- standard air handling with enthalpy (aka energy) wheels
- energy recovery for distributed equipment (e.g. unit ventilators)
- fixed-plate or run-around loop exchangers for applications where air-to-air exchange is prohibited

2. Control ventilation rates to provide just the right amount of fresh air for actual occupancy and activity levels. This can be done with detailed scheduling and demand-controlled ventilation, as required by the Code.

RIGHT-SIZING EQUIPMENT

*Bigger is **not** better when it comes to sizing HVAC equipment.*

Oversized systems cost more to install and operate, provide poor dehumidification, cycle on/off too quickly (causing extra wear-and-tear), and can decrease occupant comfort.

The energy code requires that engineers use accurate heating and cooling load calculations to size HVAC equipment. These calculations must take into account the design of the building envelope, lighting, ventilation, and occupancy loads. The loads must be adjusted to account for the inclusion of energy recovery components in the HVAC system design.

Make sure your team uses accurate calculations in order to right-size the equipment. Right-sizing saves both energy and life-cycle costs, and results in a higher level of system performance.

Funding provided in whole or in part by the Illinois EPA Office of Energy. This material is based upon work supported by the U.S. Department of Energy, under the State Energy Program Award Number DE-EE0008646.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

TIPS TO IMPROVE INDOOR AIR QUALITY

Designers (architects and engineers)

- Comply with the current energy code's specifications for proper building envelope design and details
- Select efficient mechanical equipment and size systems properly. Select controls with easy to use program/protocol.

Contractors

- Utilize proper construction practices to maintain integrity of building envelope following design intent and code requirements.
- Install HVAC systems per manufacturer's manual/ specification and code requirements.

Code officials

- Enforce proper documentation of code compliance, especially blower door test
- Use tools to effectively enforce energy code
- Understand code requirements related to indoor air quality

3rd party testing agencies

- Provide correct testing environment
- Enforce proper test procedures
- Enforce proper documentation and report

Homeowners

- Request information on energy code compliance from builders or real estate agencies
- Utilize maintenance practices including regular mechanical system checkeups
- Seal water and air leaks
- Don't turn off automatic ventilation system

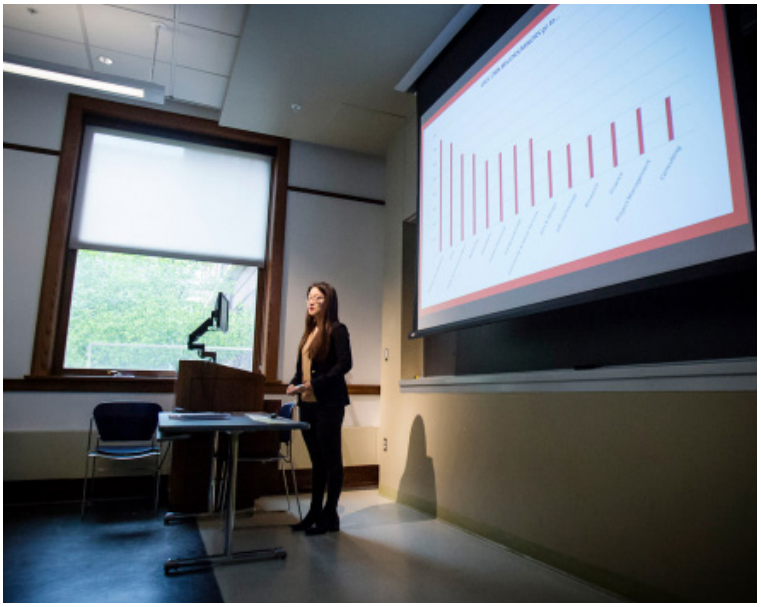
SAVE ENERGY AND MONEY WITH SEDAC

SEDAC helps buildings and communities unlock savings opportunities, navigate energy efficiency programs, and implement energy savings measures. We offer independent, expert technical assistance to help you save energy and money. Partner with us!

SEDAC SERVICES

- Quick Advice
- Energy Assessments
- New Construction Design Assistance
- Long-term energy planning
- Retro-commissioning

apply.sedac.org



SEDAC Workshops

ENERGY CODE TRAINING AND SUPPORT

sedac.org/energy-code

SEDAC, in partnership with the Illinois EPA Office of Energy, provides energy code training and support for professionals throughout Illinois. Whether you want to get up to date on the latest code requirements, receive continuing education credit, or get a quick answer to an energy code question, we're here to help! Training and support are available at no cost to customers.*

Workshops

Network with code officials, architects, and building professionals at our energy code workshops.

Webinars and online courses

Webinars and online courses provide convenient learning opportunities for busy professionals.

Technical support

Confused by a code requirement? Contact us for individualized guidance

- 800.214.7954
- energycode@sedac.org

WHO WE ARE

The Smart Energy Design Assistance Center assists buildings and communities in achieving energy efficiency, saving money, and becoming more sustainable. SEDAC is an applied research program at the University of Illinois at Urbana-Champaign working in collaboration with the 360 Energy Group.

*Funding provided in whole or in part by the Illinois EPA Office of Energy

Funding provided in whole or in part by the Illinois EPA Office of Energy. This material is based upon work supported by the U.S. Department of Energy, under the State Energy Program Award Number DE-EE0008646.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY