





**Maximizing Indoor Environmental Quality
with ENERGY STAR®**


*U.S. Environmental Protection Agency (EPA)
2008*

 Learn more at energystar.gov




1. **Overview of ENERGY STAR**
2. ENERGY STAR & The LEED® Rating System
3. ENERGY STAR & Indoor Environmental Quality
4. Additional Information

 Learn more at energystar.gov



What is ENERGY STAR?

- A government-backed, voluntary program that helps businesses and individuals protect the environment through superior energy performance by providing energy-efficient solutions for homes, businesses, and institutions.
- The national symbol for environmental protection through energy efficiency, recognized by more than 70% of all U.S. households.



ENERGY STAR



Also ENERGY STAR



Twin Peaks Charter Academy
Longmont, CO



Shriners' Hospital for Children
Houston, TX



500 Boylston St.
Boston, MA



Hillsborough County Water Department Administration Building
Hillsborough County, FL



Westin San Francisco Airport
Millbrae, CA



AEGON Center
Louisville, KY



Blue Earth County Courthouse
Mankato, MN



Opportunities in Buildings



- Commercial buildings and industrial facilities generate about **50 percent** of U.S. carbon dioxide emissions.
- **30 percent** of energy consumed in commercial and industrial buildings is wasted.
- Energy costs represent a typical school district's second largest operating expense, after salaries—more than the cost of computers and textbooks combined.
- Reductions of **10 percent** in energy use can be possible with little or no cost.



ENERGY STAR for Buildings



- ENERGY STAR qualified buildings use 35 percent less energy than average buildings.
- More than 5,500 buildings, including more than 1,300 K-12 schools, have earned the ENERGY STAR for energy efficiency.



Georgetown Elementary School
Georgetown Exempted Village
School District, OH



Glenn Elementary School
McLean County Unit School
District #5, IL



Join ENERGY STAR



- More than 3,000 Partners operating more than 13 billion square feet of space (nearly 20 percent of space in the U.S.).
- More than 78,000 buildings, representing nearly 11 billion square feet of space, have measured their energy performance with ENERGY STAR using Portfolio Manager.
- Visit www.energystar.gov/join and join now.



National and Local Recognition



- ENERGY STAR Partner
- Designed to Earn the ENERGY STAR
- The ENERGY STAR for Existing Buildings
- ENERGY STAR Leaders
- ENERGY STAR Partner of the Year



New Commercial Construction



Target Finder

- Determine the energy performance rating, percent energy reduction, and the percent CO₂ reduction corresponding to estimated energy use for new building designs.
- Achieve Designed to Earn the ENERGY STAR if your rating ≥ 75 .



DESIGNED TO EARN THE ENERGY STAR

The predicted energy performance for this design meets LEED criteria. The building will be eligible for ENERGY STAR after maintaining superior performance for one year.

Designed to Earn the ENERGY STAR



Odyssey Charter School – Prototype 2, FL



Sandia Vista Elementary School, NM



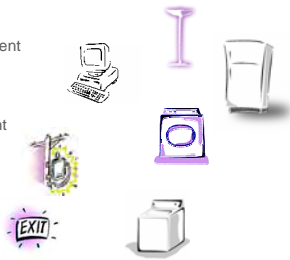
DESIGNED TO EARN THE ENERGY STAR

The predicted energy performance for this design meets LEED criteria. The building will be eligible for ENERGY STAR after maintaining superior performance for one year.

Qualified Products for K-12



- Water Coolers
- Commercial Kitchen Equipment
- Lighting
- Office Equipment
- Heating & Cooling Equipment
- Transformers
- Ventilation Fans
- Appliances
- Consumer Electronics



more than 50 product categories

ENERGY STAR Purchasing



- ENERGY STAR qualified products are available for more than 50 product categories.
- Savings calculators and drop-in procurement language are available.
- Quantity Quotes: A Web site created by the U.S. Department of Energy to connect large-quantity buyers with suppliers of energy-efficient products.
- Get started at www.energystar.gov/purchasing and www.energystar.gov/quantityquotes.





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ENERGY STAR and LEED



LEED-NC EA Credit 1:

- Option 1: Whole building energy simulation. Projects can obtain the data from Target Finder.

LEED for Schools EA Prerequisite 2:

- Projects must establish an energy performance rating goal for the design using Target Finder.

LEED-EB (O&M) EA Prerequisite 2:

- Submissions must obtain an energy performance rating of 69 using Portfolio Manager.



Fossil Ridge High School



- Located in Fort Collins, CO
- Completed in 2004
- 296,000 Sq. Ft.
- Earned the ENERGY STAR in 2005, 2006, and 2007
- LEED Silver Certified



Partner of the Year Award: Council Rock School District



- Earned ENERGY STAR Leaders recognition in 2007 for 20 and 30 percent improvement
- Saved more than \$2.5 million in just two years
- Prevented greenhouse gas emissions equivalent to those from more than 1,000 vehicles



Partner of the Year Award: Gresham-Barlow School District



- Earned ENERGY STAR Leaders recognition in 2005
- Achieved Top Performer recognition
- Became the first district to receive the Partner of the Year Award twice
- Saved more than \$1.3 million in utility costs in 2007



Take the ENERGY STAR Challenge



- Encourages everyone to improve the energy efficiency of America's buildings by 10 percent or more.
- More than 1,300 organizations are participating: (More than 180 schools and districts)
- Use the ENERGY STAR Challenge Toolkit for ready-to-use materials



Sign up and access the Challenge toolkit at:
www.energystar.gov/challenge





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What We Will Cover Today



- Indoor Environmental Quality (IEQ) and Energy Efficiency in Context
- Potential benefits for integrating IEQ into Energy Efficiency
- Basic Indoor Air Quality (IAQ) dynamics and principles to incorporate into energy-efficient operations
- HVAC, lighting, and other systems and how they affect both IEQ and Energy Efficiency



Let's Get Together



Savings of 40 - 45% possible with energy saving actions compatible with IEQ

Energy Cost and IAQ Performance of Ventilation Systems and Controls

www.epa.gov/iaq/largebldgs/index.html



IAQ is a Health Risk



- 90 percent of most peoples' time is spent indoors
- Pollutant levels indoors are often higher than outdoors
- Ranked in top three environmental health risks by EPA's Science Advisory Board



Why Incorporate IEQ?



- **Improves health, comfort, and performance of students / staff**
- **Documented health and performance benefits**
 - Reduced absences (\$)
 - Improved student performance (\$)
 - Improved perceptions and lower turnover (\$)
 - Reduced liability (\$)
- **Needed for the ENERGY STAR**



Overview: Key Factors



- | <u>Energy Efficiency</u> | <u>IEQ</u> |
|--|--|
| • Outdoor Climate | • Outdoor climate and pollution |
| • Building envelope | • Building envelope |
| • HVAC <ul style="list-style-type: none">- Outdoor Air (OA) ventilation requirements- T-RH setpoints- Equipment sizing- Equipment efficiencies- Equipment, energy performance and operating controls | • HVAC <ul style="list-style-type: none">- OA ventilation rate needs- Occupant needs for T-RH- Sufficient equipment capacity- Reliable functional performance |
| • Lighting loads | • Lighting quality |
| • Other loads | • Indoor pollution source loads |



Outline for What To Do



- > HVAC
 - Upgrades
 - Re-commissioning
 - Operations-Maintenance
- > Lighting
 - Upgrades
 - Operations-Maintenance
- > Miscellaneous Loads
- > Summary of Good Practice



HVAC



- > Principles for IEQ / Energy Efficiency Compatibility
 - Meet ASHRAE standards for OA ventilation
 - Minimize energy use of OA ventilation
 - Maximize effectiveness of OA ventilation
 - Maximize pollutant removal of outgoing air
 - Right size for energy efficiency



Air Handling Units



➤ Minimize energy of OA delivery

- Constant Volume (CV) to Variable Air Volume (VAV) saves fan energy (10% - 20%)
- Economizers
 - Saves energy (6 - 10%). Good for IAQ
 - **Regular preventative maintenance is critical. Failures can cause IEQ and energy efficiency problems**



Fans, Motors, & Drives



➤ No (minimal) impact on IEQ

- Fan system right-sizing
- Variable speed drives
- Energy efficiency motors
- Useful to check OA flow for adequacy after installation



Re-Commissioning



➤ Potential for significant energy savings and improved IEQ

- Purposeful maintenance and repairs undertaken at a specific time to bring systems to peak operating performance
- Calibrate controls (sensors, thermostats)



Lighting



- System upgrades improves lighting quality, reduces energy, reduces heat load
 - Use more energy
 - Compromise IEQ
- Improved lighting quality, productivity, comfort, safety, less noise (electronic ballasts)
- Reduced heat load could reduce OA flow
- **Janitorial:** Check dust accumulation on fixtures/lenses. Clean as needed. Establish a regular cleaning protocol
- **Maintenance:** Relamp/change ballasts as needed. Establish a regular relamping program



Miscellaneous Load Reductions



Plug Loads

- Office equipment, kitchen equipment, water coolers etc.
 - Use ENERGY STAR qualified equipment to reduce energy use and reduce wasted heat energy

External Loads

- Upgrade building shell, window films/shades
 - Reduces heat load from external sources

IEQ

- Same as for lighting. Reduced heat load could reduce OA flow
- Check OA flow for adequacy (ASHRAE Standard)



IAQ Resources



IAQ Tools for Schools & IAQ Design Tools for Schools

www.epa.gov/iaq----->schools

IAQ Building Education and Assessment Model (I-BEAM)

www.epa.gov/iaq----->large buildings



For More Information



Visit www.energystar.gov/schools
E-mail buildings@energystar.gov

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Indoor Air Mass Balance

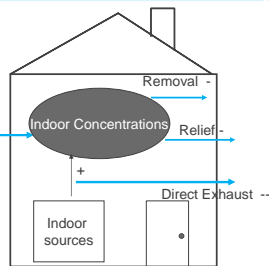


Outdoor air with outdoor pollution dilutes indoor contaminants and creates background IAQ

$$OA = R + E$$

↑ Bldg Pressure ↓

Pressure relationships inside determine pollutant pathways



What To Look Out for to Protect IEQ: Major Principles



- Outdoor air (OA) flow (space - time)
- Pollutant exhaust
- Temperature or Relative Humidity (RH) (space - time)
- Pressure
 - Outdoor ↔ Indoor Indoor ↔ Indoor
- Moisture & Mold
 - Moisture intrusions, leaks → mold
 - RH + surface temperature → condensation → mold



Current ASHRAE Thermal Standard



Temperature and Humidity Standard

- ASHRAE Standard 55-2004
 - Maintaining a building within the following ranges of temperature and relative humidity will generally satisfy thermal comfort requirements:

	Winter	Summer
Dry Bulb at 30% RH	68.5°F - 76.0°F	74.0°F - 80.0°F
Dry Bulb at 50% RH	68.5°F - 74.5°F	73.0°F - 79.0°F
Wet bulb maximum	64°F	68°F
Relative humidity *	30% - 60%	30% - 60%

* Upper bound of 50% RH will also control dust mites.



HVAC Upgrades



- Meet ASHRAE Standards
 - Right size for energy efficiency, but for IEQ:
 - Calculate peak load carefully
 - Consider both sensible and latent loads
 - Consider high occupancy periods



Air Handling Upgrades



➤ Minimize energy of OA delivery

- Constant Volume (CV) to Variable Air Volume (VAV) saves fan energy (10% - 20%)
 - VAV with fixed OA damper. **Bad for IAQ**
 - VAV with modulating damper is OK for IAQ with little if any energy penalty
 - Consider dedicated OA ducts
- Economizers
 - Saves energy (6 - 10%). Good for IAQ
 - Capable of delivering up to 100% outside air
 - Excess ventilation helps dilute indoor generated pollutants (improves IEQ) and saves energy
 - Humidity problems with temperature regulated controls—enthalpy preferred
 - **Regular preventative maintenance (PM) is critical. Failures can cause IEQ and energy efficiency problems**



Energy Recovery Ventilation (ERV)



➤ Reduce energy needed for OA

- ERV Energy Exchange: Heat and humidity are transferred between incoming and exiting air flows
- Especially useful in high occupant density buildings where OA ventilation requirements are high
- Can significantly reduce energy cost of high outdoor air requirements

➤ Evaluate technical and economic viability at www.epa.gov/iaq/schooldesign/saves.html



HVAC



➤ Maximize Effectiveness of OA delivered

- Avoid short circuiting
- Ensure free air flow—e.g. no books on unit ventilator
- Building pressurization—indoor to outdoor
 - Building under slight positive pressure. Cold climates—neutral pressure



HVAC: Exhaust



- **Maximize pollutant removal of exiting air**
 - Exhaust ventilation is the most effective way of removing contaminants from point sources in the building to avoid occupant exposures
 - Can also remove excess heat (e.g. from copy rooms, kitchens, etc.)
 - Reduces need of OA dilution of contaminants
- **All strong contaminant point sources should be exhausted to the outside for IAQ**
 - Toilet facilities
 - Shower/locker rooms
 - Janitorial closets
 - Cooking facilities
 - Underground parking
 - Smoking lounges
 - Laboratories (may require fume hoods)
 - Reproduction and graphic arts areas
- **Ensure that pollutant source locations are under negative pressure relative to surrounding space (exhaust > supply)**



Heating and Cooling Upgrades



- **Consider chiller and boiler retrofits and upgrades to improve energy efficiency, reduce CFC use, and improve thermal control in your building**
- **Adhere to the following IEQ guidelines**
 - Installation provides good access for cleaning and maintenance for both chillers and boilers
 - Sufficient air is supplied to boilers to support combustion and proper exhaust of flue gases
 - Boiler room needs to be under neutral pressure to avoid backdrafting of flue gasses
 - Consider a dedicated outdoor air supply to the boiler to support combustion



Re-Commissioning



- **Re-commissioning**
 - Purposeful maintenance and repairs undertaken at a specific time to bring systems to peak operating performance
 - Saves energy, improves IEQ
- **Need to re-commission is minimized**
 - Maintenance: Ongoing process to keep systems operating at peak performance levels
 - Janitorial services: Ongoing process to keep building surfaces in occupied spaces clean for health, comfort, and operational efficiencies
- **Potential for significant energy savings through re-commissioning**



Re-Commissioning: Controls



- **Efficient and effective performance of HVAC depends on controls.**
 - Important for both IAQ and energy efficiency
- **Over time, thermostats, humidistats, and other sensors/controls get out of calibration.**
 - Occupant discomfort and/or health are compromised, and energy loads are increased
- **Calibrate indoor and outdoor sensors**
 - Room thermostats, in-duct thermostats and humidistats, pressure sensors, time clocks etc.



Re-Commissioning: Controls



- **For IAQ: Inspect damper and valve controls.**
 - Improperly functioning air flow dampers can reduce outdoor air ventilation and/or create other imbalances
 - Malfunctioning economizers both create thermal problems and reduce energy efficiency
- **For IAQ: Check operating schedules to ensure that they match current building occupancy schedules.**
 - Take advantage of opportunities for night time setback, night precooling, and off-peak equipment operation, but:
 - Ensure HVAC operations during all occupied hours
 - Ensure adequate lead time for HVAC prior to occupancy
 - Avoid condensation on cold surfaces during night pre-cooling operation



Lighting Upgrades



- System upgrades improve lighting quality, reduces energy, reduces heat load**
- Fluorescent lamp upgrades
 - Compact fluorescent lamps (CFLs) to replace incandescent lights
 - LED exit signs—HID lamp upgrades
 - Automatic controls—time based, occupancy based, light based
- IEQ**
- Improved lighting quality, productivity, comfort, safety, less noise (electronic ballasts)
 - Reduced heat load could reduce OA flow
 - Check OA flow



Actions Compatible with IEQ



- Efficient fans, motors, drives: **OK**
- Efficient chillers/boilers: **OK**
- Reduce lighting/office equipment use at night: **OK**
- Energy recovery: **Good**
- Preventive maintenance: **Good**
- Commissioning controls & equipment: **Good**

OK = Reduces energy with no impact on IEQ or where IEQ can easily be protected
Good = Reduces energy and could improve IEQ



Actions Compatible With IEQ With Cautions



- **Air-side economizer: Good**
 - Watch Relative Humidity (RH) and polluted outdoor air
- **Building shell: OK**
 - Watch infiltration rate and adjust OA supply accordingly
- **Reduce internal loads: OK**
 - Avoid non ENERGY STAR qualified upgrades to protect against inadequate lighting quality
 - Recalibrate OA control under VAV systems
- **Equipment Downsizing: OK**
 - Watch peak load -- use with Energy Recovery