



The Intersection of IAQ and Energy Efficiency – October 17, 2024

William Bahnfleth

Professor, The Pennsylvania State University

Presidential Member/Fellow, ASHRAE

wbahnfleth@psu.edu



PennState
College of Engineering

ARCHITECTURAL
ENGINEERING



We build for people, not to save energy

“That all people should have free access to air and water of acceptable quality is a fundamental human right.”

~World Health Organization (2000) *Air Quality Guidelines for Europe, 2nd ed.*

“An energy declaration without a declaration related to the indoor environment makes no sense.”

~B. Olesen, O. Seppänen, A. Boerstra (2006) *Criteria for the Indoor Environment for Energy Performance Of Buildings – A New European Standard*. *Facilities* 24 (11/12): 445-457.

Good IAQ is essential to sustainability



A large body of research documents the impacts of IAQ

- Health
- Productivity
- School performance
- Airborne disease transmission
- Sleep quality

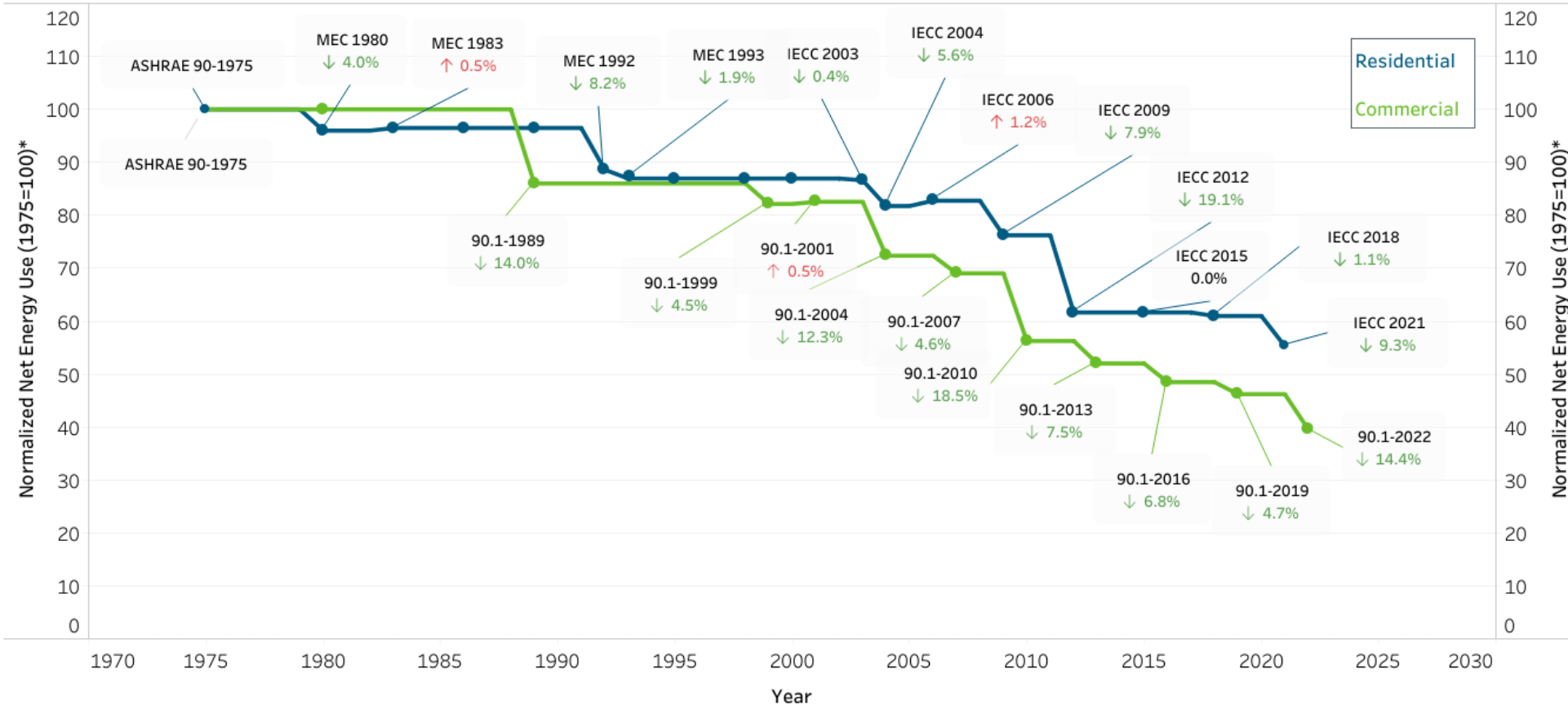
Effects are personal as well as societal, monetizeable

Increasing energy efficiency has taken precedence
over improving IAQ for nearly a century

Design – New Construction, Additions, Major Renovations



Estimated Improvement in Residential & Commercial Energy Codes (1975 - 2022)

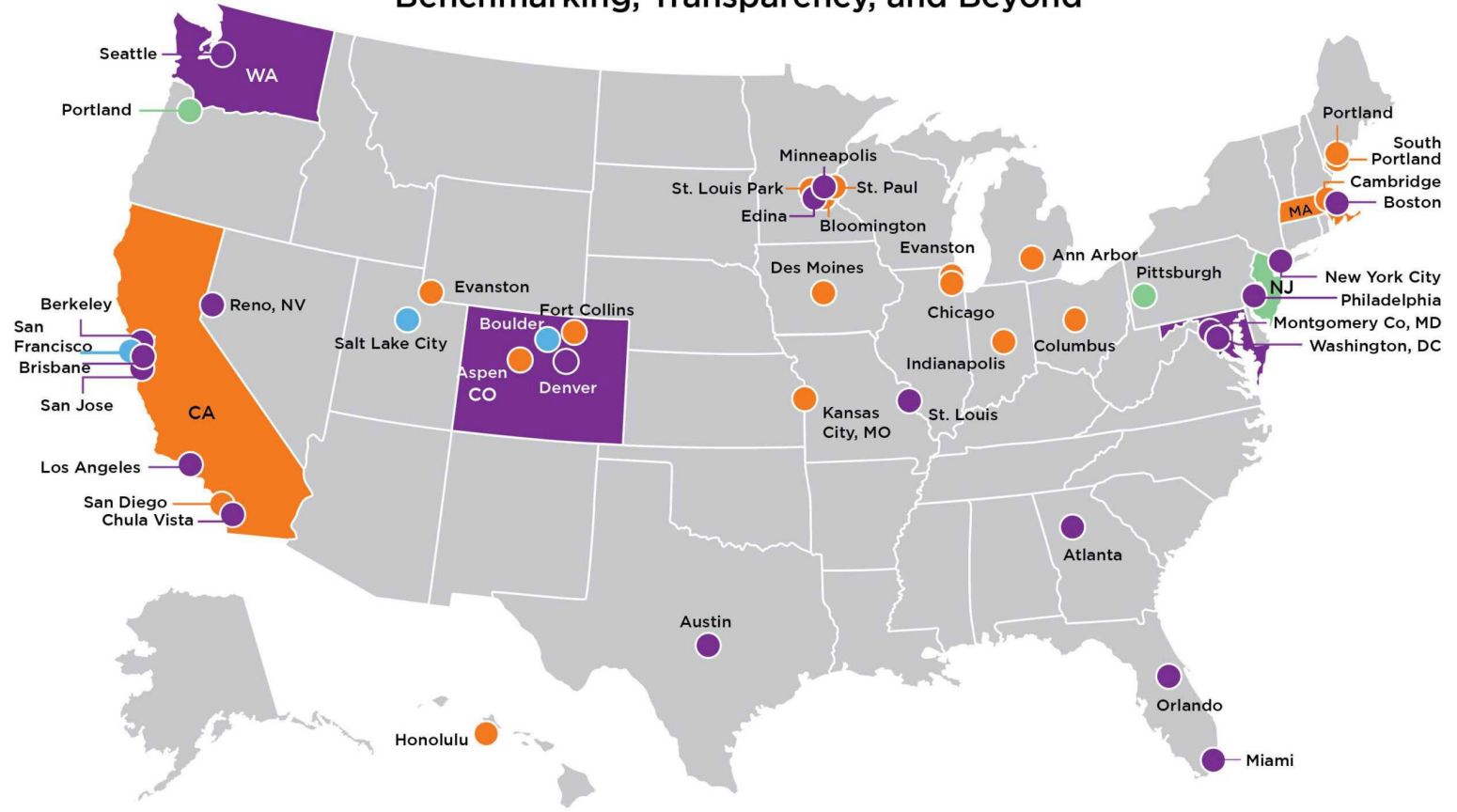


*Net energy use includes the contribution of renewable energy generation

<https://www.energycodes.gov/infographics>

Operation

U.S. City, County, and State Policies for Existing Buildings: Benchmarking, Transparency, and Beyond



- Benchmarking required for public and commercial buildings
- Benchmarking required for public, commercial, and multifamily buildings
- Benchmarking and additional actions required for public and commercial buildings
- Benchmarking and additional actions required for public, commercial, and multifamily buildings



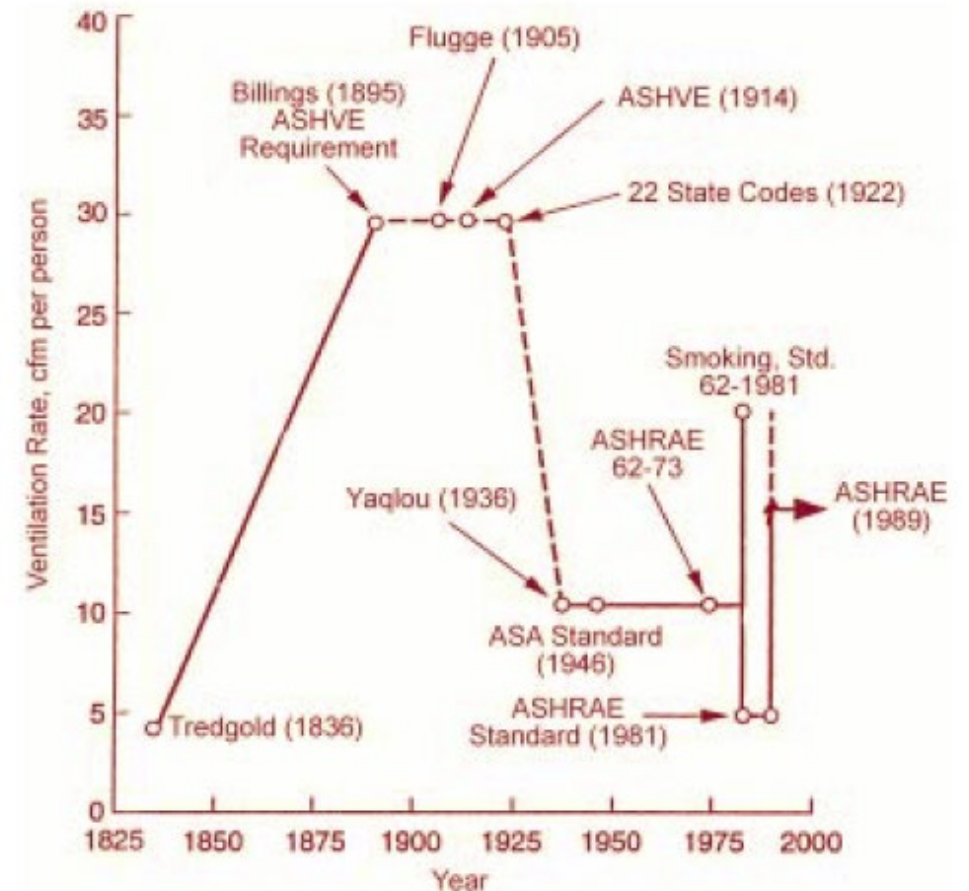
© Copyright 2022 Institute for Market Transformation. Updated 08/2022.

Acceptable Indoor Air Quality

Air in which there are *no known contaminants at harmful concentrations*, as determined by cognizant authorities, and with which *a substantial majority (80% or more) of the people exposed do not express dissatisfaction*.

~ASHRAE Standard 62-1981

~ASHRAE Standard 62.1-2022



Janssen, J.E., 1999. The history of ventilation and temperature control: The first century of air conditioning. ASHRAE Journal, 41(10), p.48.

Better IAQ and energy efficiency are possible

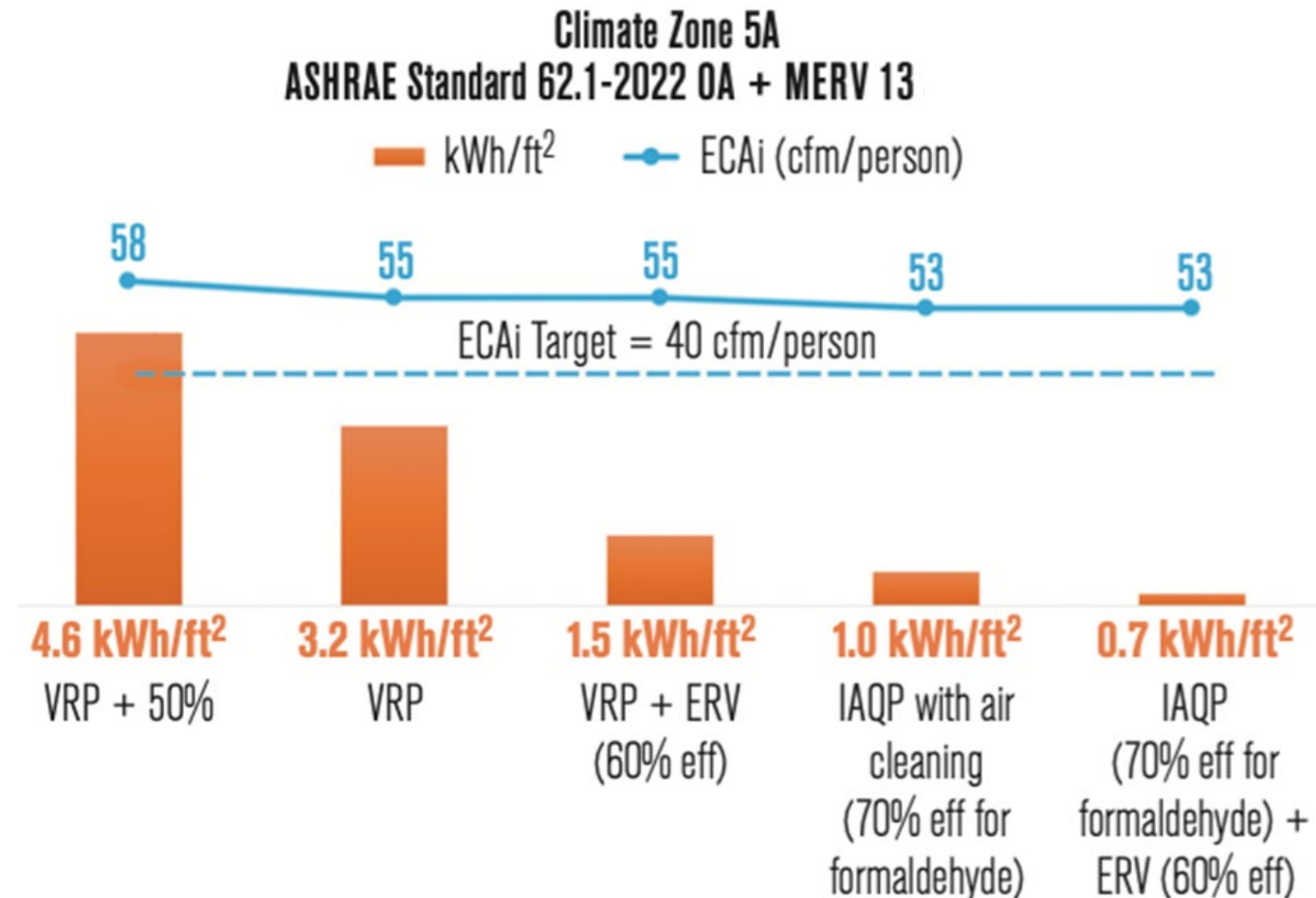
Example: Primary School
 73,959 ft² (6871 m²)
 1,478 People

With MERV 13 filter, exceeds
 ASHRAE 241 ECAi requirement

VRP = outdoor air per ASHRAE 62.1-2022
 prescriptive Ventilation Rate Procedure

IAQP = Outdoor air per ASHRAE Standard
 62.1-2022 performance-based approach with
 sorbent filters capable of removing
 formaldehyde (HCHO) at efficiency of 70%

ERV = Energy Recovery Ventilation



Zaatari, M, A. Goel, and J. Maser. 2023. ASHRAE J. 65(9):18-24.

Covid created momentum for addressing
IAQ, but it's already fading – act now!

Path forward

- Many elements of efficient IAQ exist
 - *Equivalent Clean Air* approach to application (ASHRAE Std 241)
 - Air cleaner technologies (but need better effectiveness and safety tests)
 - Performance path in minimum IAQ standards (62.1 IAQP)
 - Baseline sensor technologies
- Better education/workforce development is needed
- The most serious gap is regulatory
 - No national standards even for design
 - No operational regulations for most buildings...
 - No Clean Air Act for indoor air
- Important research gaps exist, but they should not stop us from acting

Focus must be on existing buildings