Australian Government

Department of the Environment and Energy

International Energy Agency-
Technology Collaboration Programs

Energy in Buildings and Communities

The International Energy Agency

- **30** member countries
- **Mission:** ensure reliable, affordable and clean energy
- **Area of focus:** energy security, economic development, environmental awareness and engagement worldwide

Technology Collaboration Programs

- **9 Research categories**:
    - Buildings and electricity
    - Industry, transport and fossil fuels
    - Fusion power and renewable energy
    - “Cross-cutting”
- **1900** energy-related topics examined
- Over **6000** experts worldwide from almost **300** public and private organisation in **53** countries

Energy in Buildings and Communities

Australia is executive committee member

24 IEA member countries and **2** partner countries

- **Activities:**
  - Adaptive thermal comfort in low-energy buildings
  - Cooling with ventilation
  - High-temperature cooling
  - Indoor air quality in low-energy buildings
- **17** ongoing projects and **60** completed
- Task shared

Australian Government
Department of the Environment and Energy

Research projects: annexes

- Led by an Operating Agent with about **10-100** researchers
- Usually **4-5** years with **2** meetings per year
- Australia has experts on only **5** of the current **17** annexes
- More participation from experts in annexes without Australian participation is encouraged
- Air Infiltration and Ventilation Centre is ongoing with annual fees

Australian Government
Department of the Environment and Energy

Online resources

List of TCPs:
https://www.iea.org/tcp/

Annexes:
http://www.iea-ebc.org/

Thank you!

Stanford.Harrison@environment.gov.au

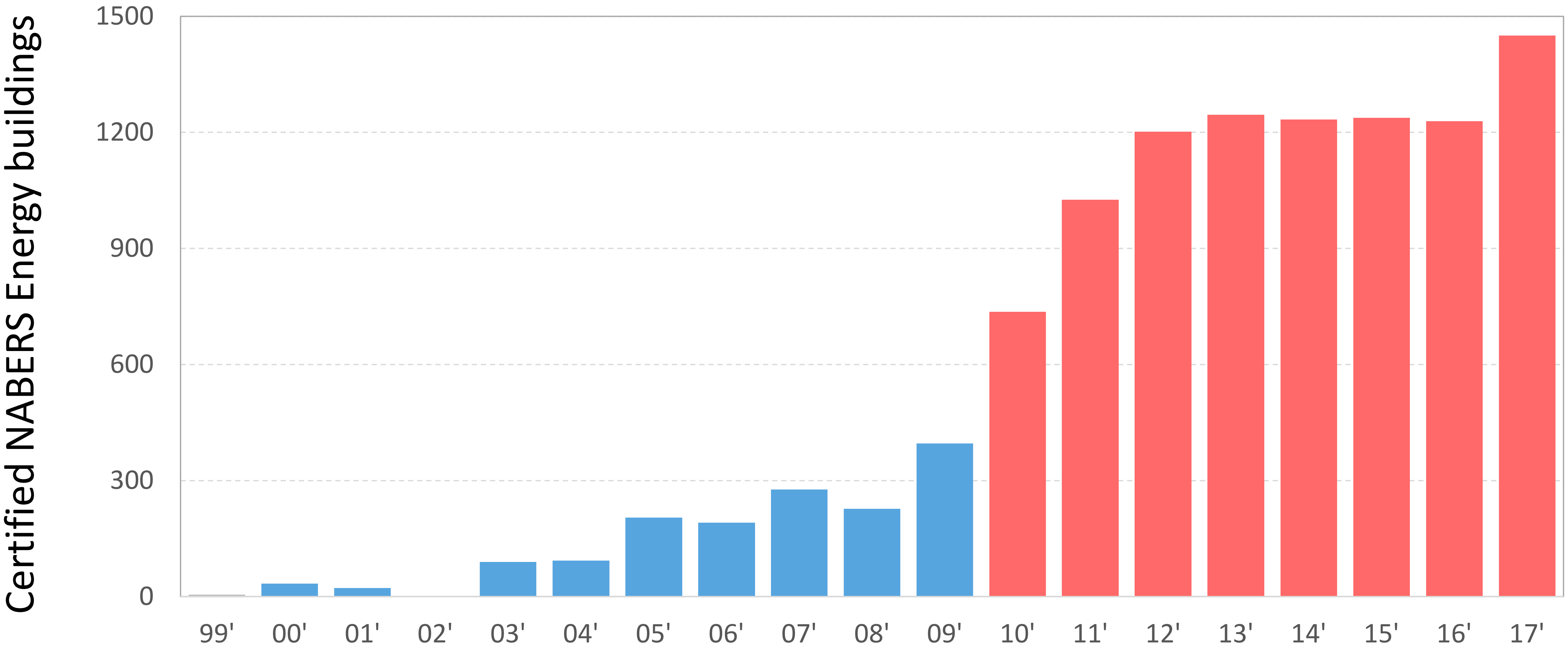
Next presentation: Carlos Flores, National Program Manager: National Build Environment Rating System (NABERS)

What can NABERS ratings tell us about ventilation and IAQ in Australian buildings

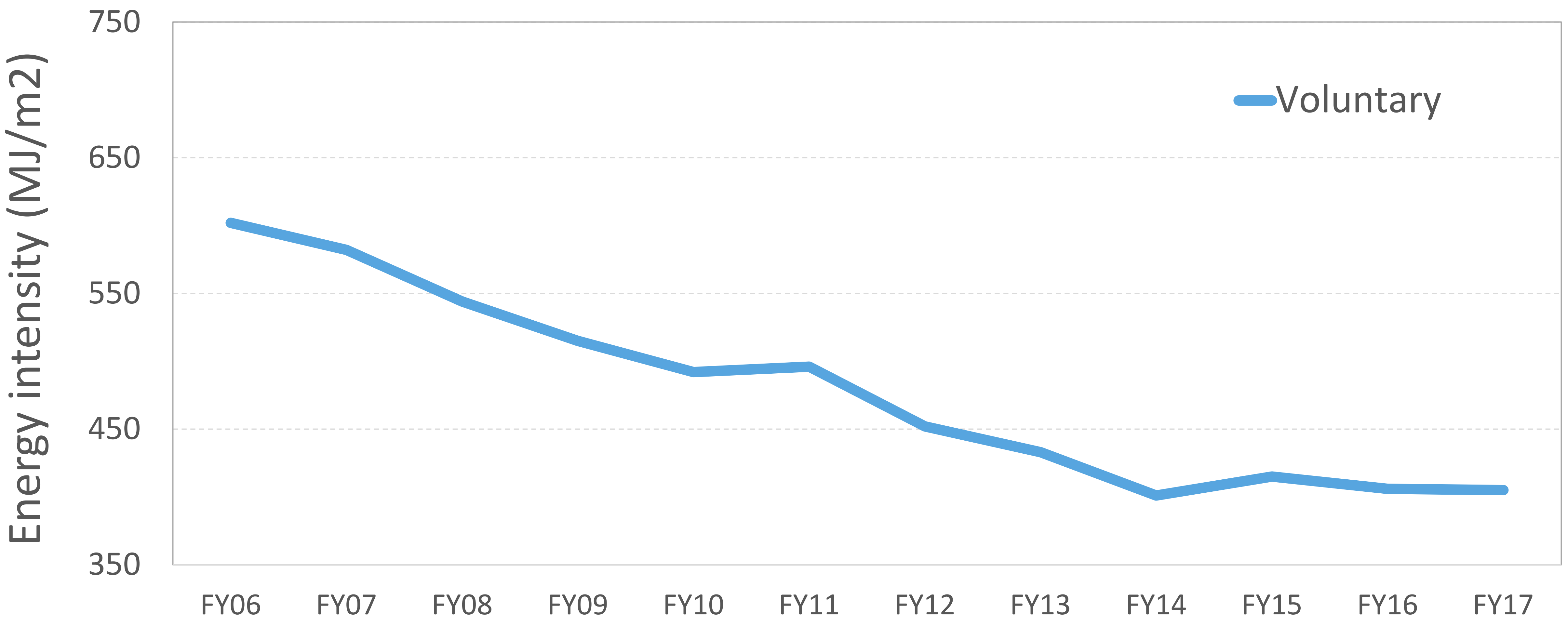
Carlos Flores | National Program Manager, NABERS

NABERS ratings provide a language for sustainability

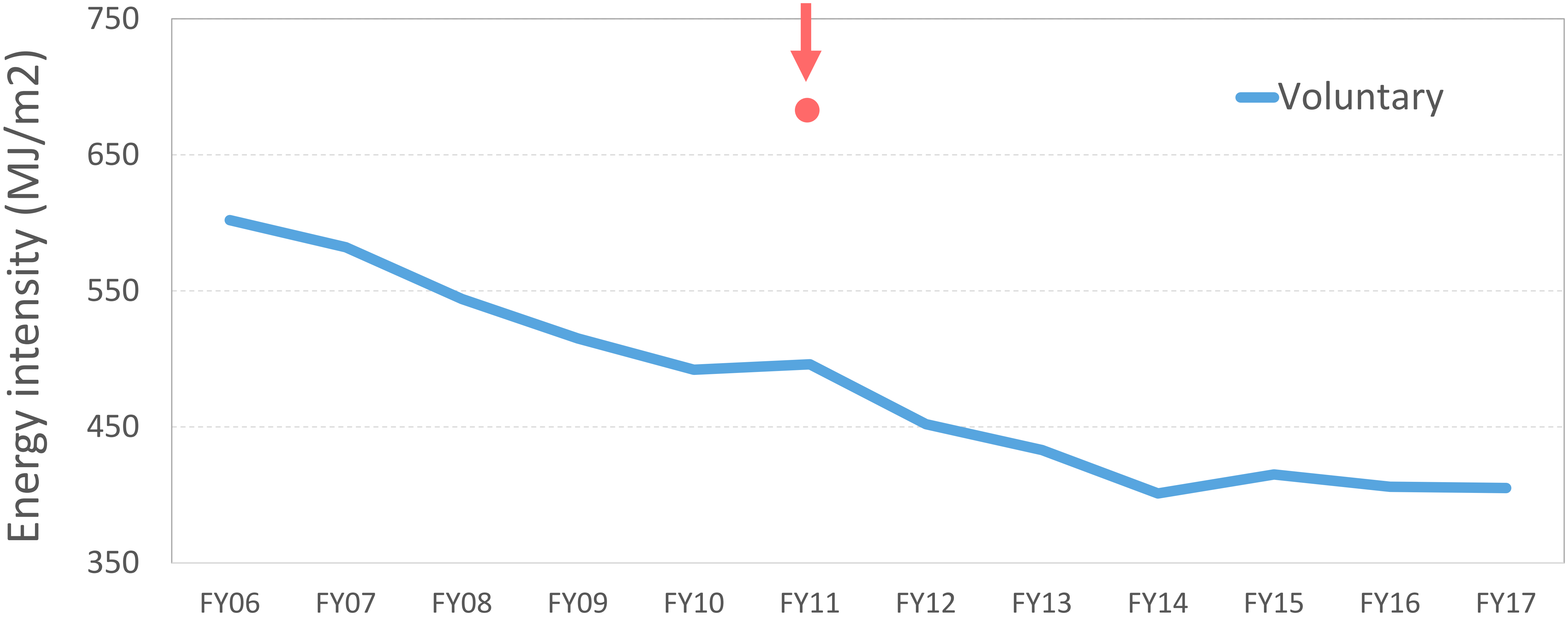
Uptake of NABERS continues to expand in the office sector



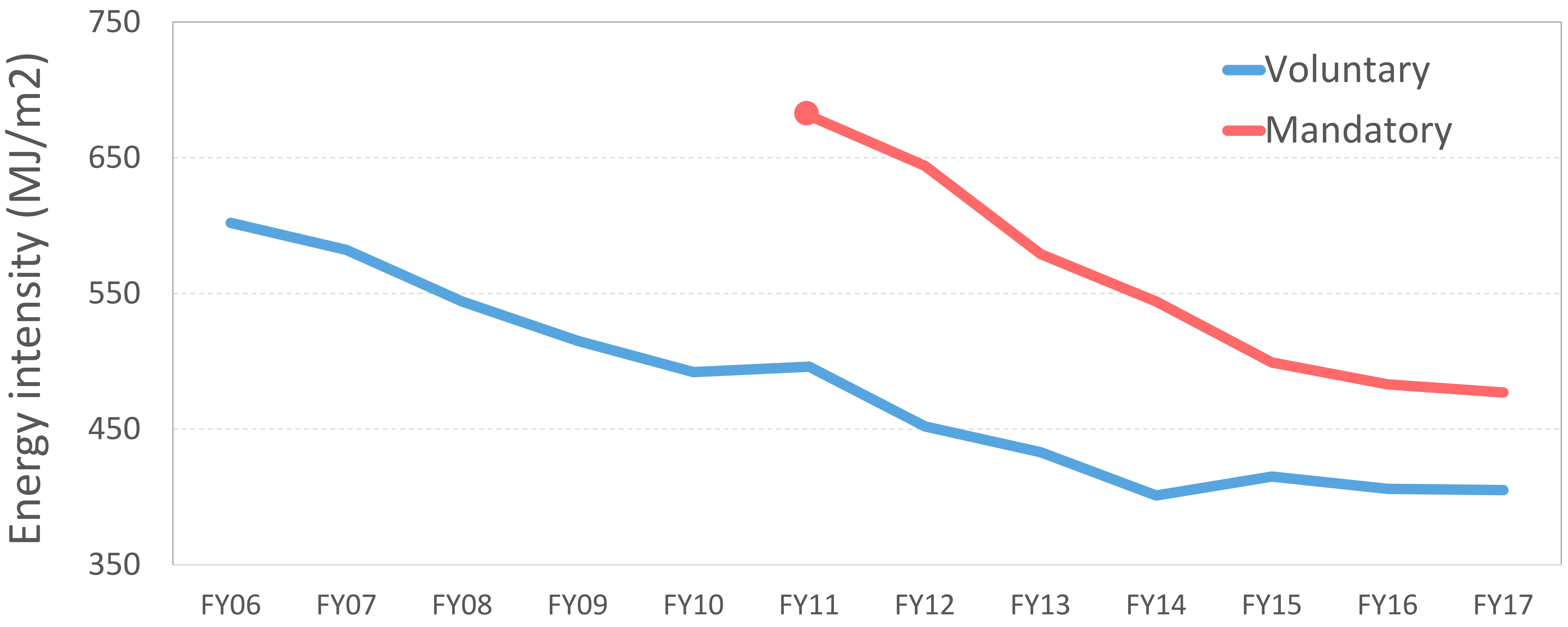
Energy use in buildings that disclosed energy voluntarily



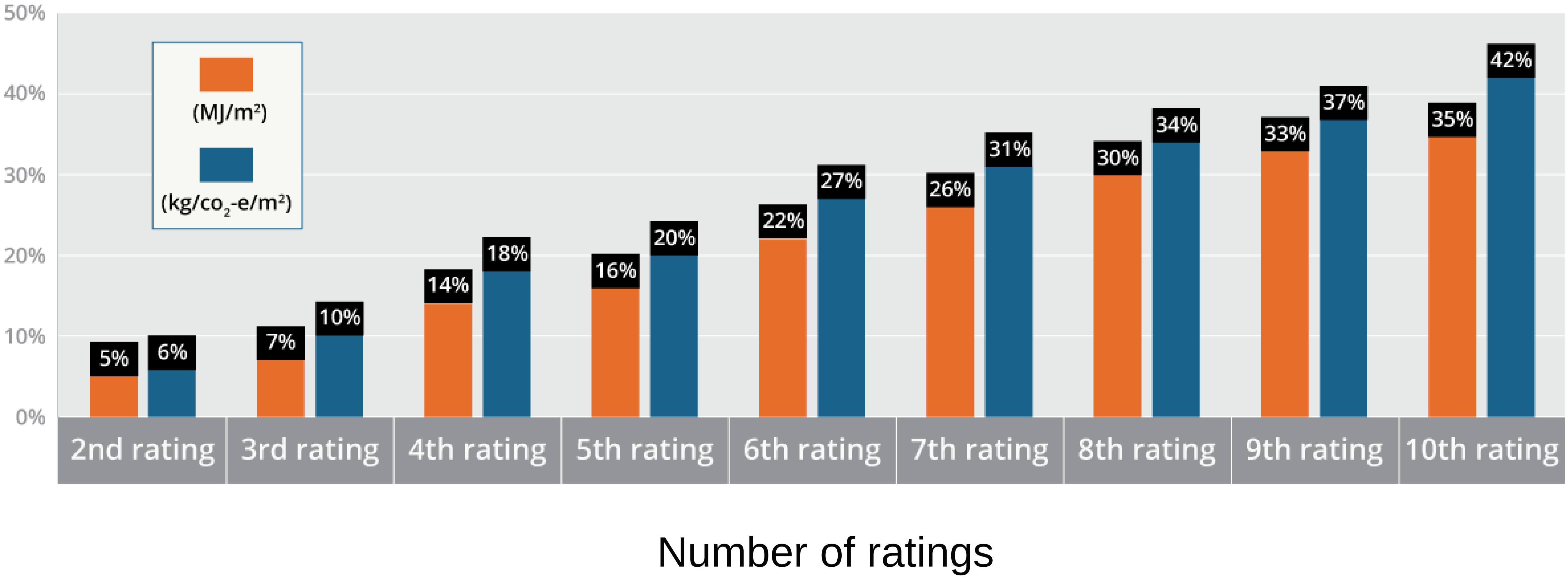
Example #3: Commercial Building Disclosure (national)



Energy in buildings that disclosed energy because of CBD

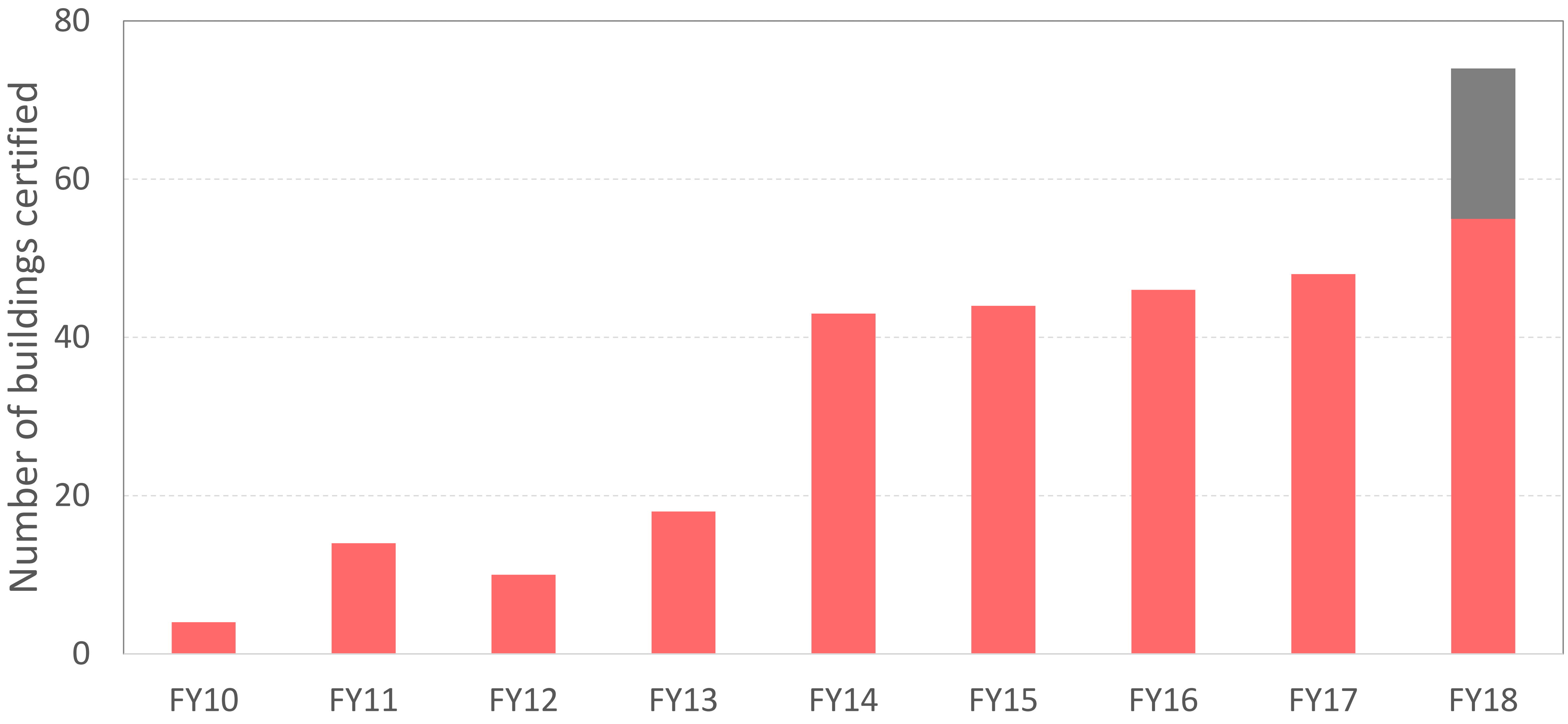


NABERS-certified buildings have one of the world's fastest rate of improvement



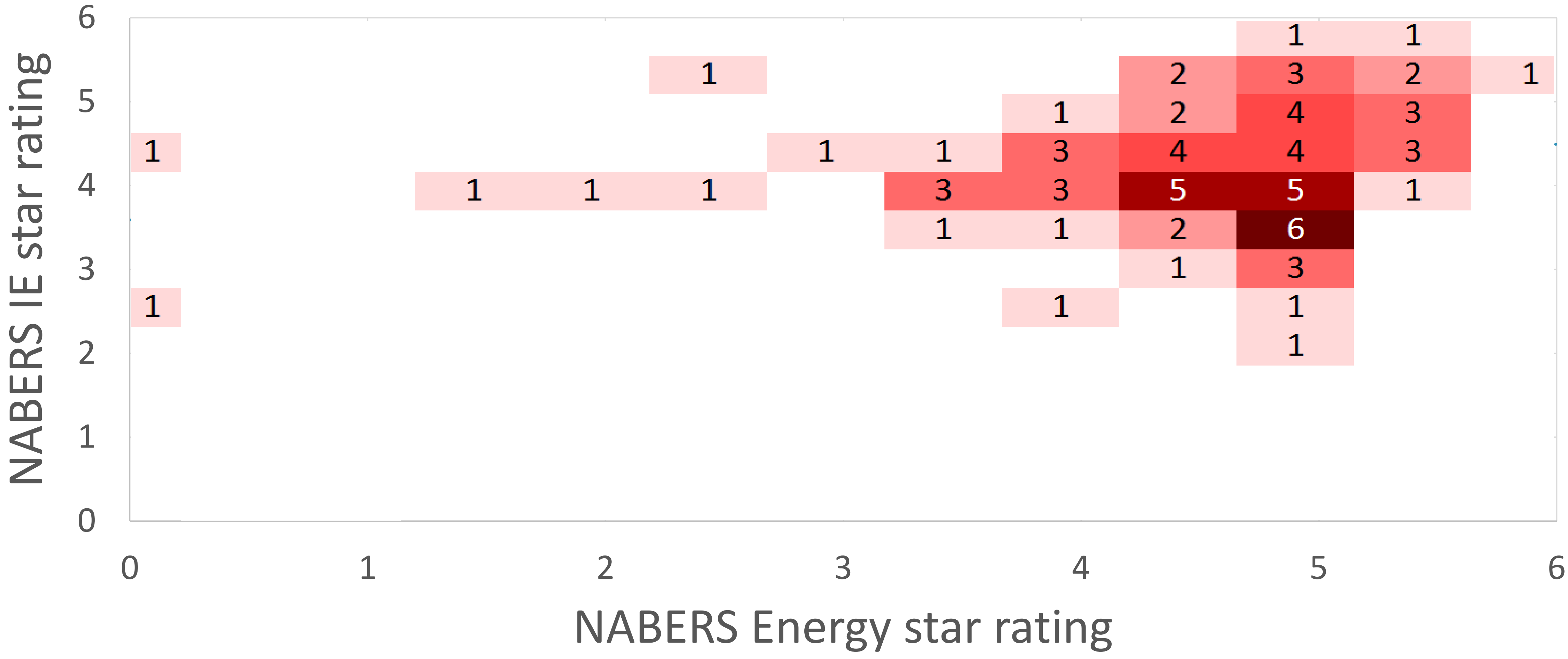
Lesson #1: there are huge HVAC energy savings to be made

Demand for NABERS Indoor Environment ratings is increasing



Lesson #2: interest in IEQ has grown significant in recent years

Buildings with high NABERS IE ratings tend to have high Energy ratings



Lesson #3: many buildings are already delivering great IEQ and low-emissions simultaneously

Thank you

Carlos.Flores@environment.nsw.gov.au

Shaping Tomorrow's
Built Environment Today
A Global Society for Building Technology

ASHRAE activities on ventilation for indoor air quality

Presenter: Professor Bjarne W. Olesen, Ph.D.
ICIEE, Technical University of Denmark
2017-2018 ASHRAE President

Extending Our Global Community

56,500+
members

15
Regions

130+
countries

180+
Chapters

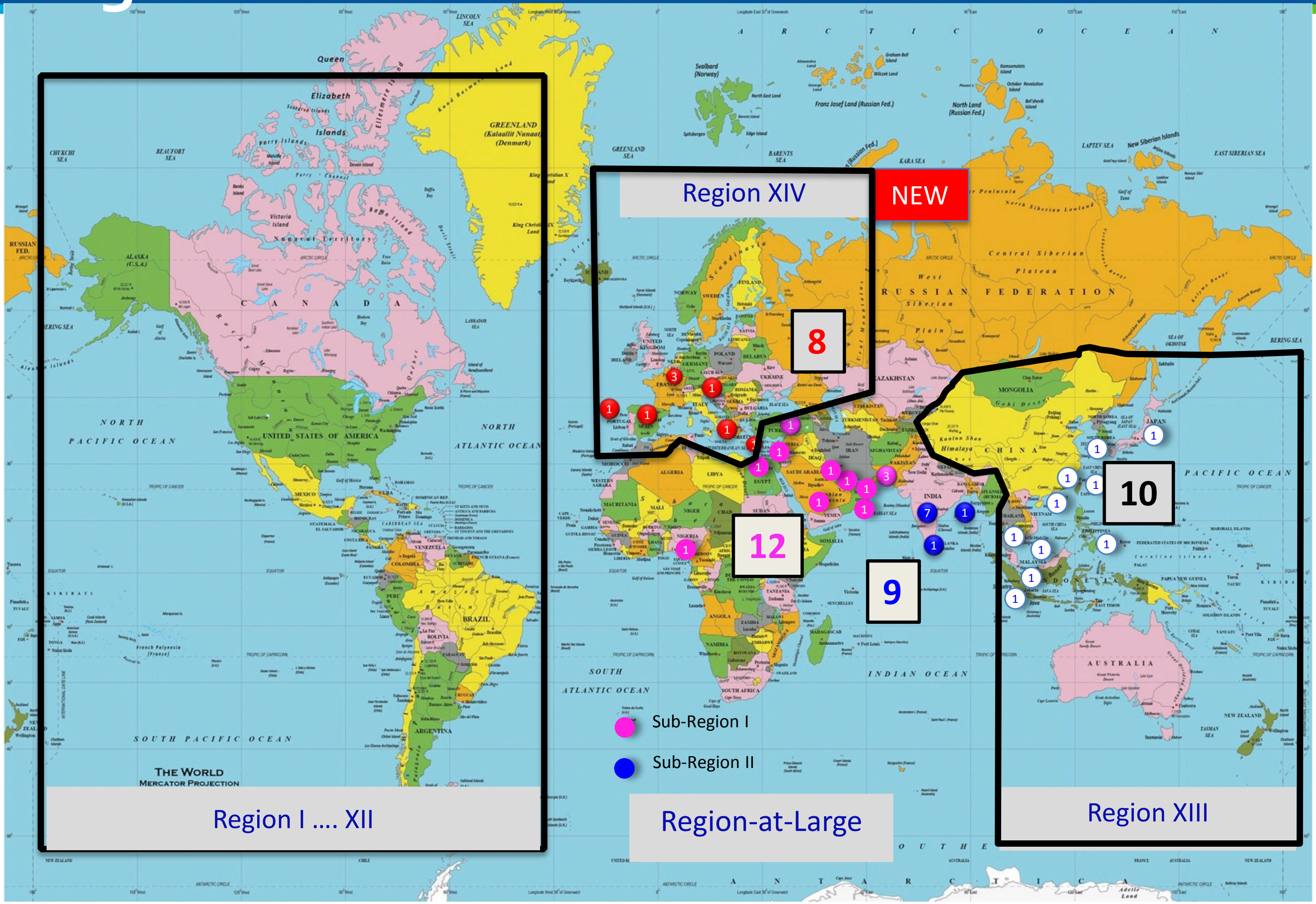
11,000+
outside N.A.

280+
Student Chapters

Chapters

186 Chapters

Regions


Region XIV
NEW
8
12
9
10
Sub-Region I
Sub-Region II
Region I XII
Region-at-Large
Region XIII
THE WORLD
MERCATOR PROJECTION

ASHRAE Overview

- Founded in 1894
- 56,000+ volunteer members in more than 130 countries

- Industry Classification
  - Consulting engineers
  - Contractors
  - Manufacturers
  - Manufacturing representatives
  - Government, health and education
  - Design build
  - Architects
- U.S./Canada (45,000+)
- Global (12,000+)

ASHRAE HQ – By The Numbers

- 128 Staff
  - 4 positions in Washington, D.C.
  - 2 attorneys (that don’t practice law, thankfully)
  - 12 engineers
  - 3 relatively new Staff Directors (Mkt, Development, Advocacy)
- Technology: 18
- Member Services: 21
- Publications & Education: 33
- Administrative Services: 20
- Marketing: 14

ASHRAE By the Numbers

- 28 standing committees
- 130 standards and guidelines committees
- 100+ technical committees
- 300+ publications
- Six certification programs
- 100+ educational courses
- Research:
  - 60+ active projects
  - Over 700 projects completed over last 50 years
  - $148 million spent on research

The Business of ASHRAE

- $30 million organization; 501(c)(3) [New Tax Bill]
- $20 million in reserves; $10 million Foundation
- Largest Revenue streams
  - Dues: $8 million
  - AHR Expo: $5.4 million
  - Advertising: $4.4 million
  - Pub Sales: $3.8 million
  - RP: $2.69 million (RECORD)
- Not-for-Profit
- Not operating at a loss
  - 2015-16: $702K surplus
  - 2016-17: $436K surplus
  - 2017-18: $300K deficit

ASHRAE Overview

What We Do

- Serve as pipeline for technical information to members, chapters and companies
- Create standards and technical guidelines to serve built environment
- Offer continuing education for industry professionals
- Serve as networking tool for industry professionals

How We Do It

- 27 standing committees
- 130 standards and guidelines committees
- 100+ technical committees
- 300+ publications
- Six certification programs
- 100+ educational courses
- Research

ASHRAE : Air Tightness-Ventilation

ASHRAE Web-site search:

• Air Tightness	290
• Air leakage	829
• Air Infiltration	904
• **Ventilation**	**5140**

How We Do It

- Handbooks
- Standards and guidelines committees
- Technical committees
- Publications
- Educational courses
- Conferences
- Research Activities

SECTION 4.0-LOAD CALCULATIONS AND ENERGY REQUIREMENTS

- 4.1 Load Calculation Data and Procedures
- 4.2 Climatic Information
- 4.3 Ventilation Requirements and Infiltration
- 4.4 Building Materials and Building Envelope Performance
- 4.5 Fenestration
- 4.7 Energy Calculations
- 4.10 Indoor Environmental Modeling
- TRG4 Indoor Air Quality Procedure Development

SECTION 5.0-VENTILATION AND AIR DISTRIBUTION

- 5.1 Fans
- 5.2 Duct Design
- 5.3 Room Air Distribution
- 5.4 Industrial Process Air Cleaning (Air Pollution Control)
- 5.5 Air-to-Air Energy Recovery
- 5.6 Control of Fire and Smoke
- 5.7 Evaporative Cooling
- 5.9 Enclosed Vehicular Facilities
- 5.10 Kitchen Ventilation
- 5.11 Humidifying Equipment

ASHRAE Standards for Ventilation

- **ANSI/ASHRAE Standard 62.1-2016**
  - **Ventilation for Acceptable Indoor Air Quality**
    - This standard applies to spaces intended for human occu- pancy within buildings except those within dwelling units in residential occupancies in which occupants are nontransient.
- **ANSI/ASHRAE Standard 62.2-2016**
  - **Ventilation and Acceptable Indoor Air Quality in Residential Buildings**
    - This standard applies to dwelling units in residential occupan- cies in which the occupants are nontransient.

ANSI/ASHRAE Standard 62.1-2016
Ventilation for Acceptable Indoor Air Quality

- ***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 major- ity (80% or more) of the people exposed do not express dis- satisfaction.

ANSI/ASHRAE Standard 62.1-2016
Ventilation for Acceptable Indoor Air Quality

- **Ventilation Rate Procedure.** The prescriptive design procedure presented in Section 6.2, in which outdoor air intake rates are determined based on space type/application, occupancy level, and floor area, shall be permitted to be used for any zone or system.

- **IAQ Procedure.** This performance-based design pro- cedure presented in Section 6.3, in which the building outdoor air intake rates and other system design parameters are based on an analysis of contaminant sources, contaminant concen- tration limits, and level of perceived indoor air acceptability, shall be permitted to be used for any zone or system.

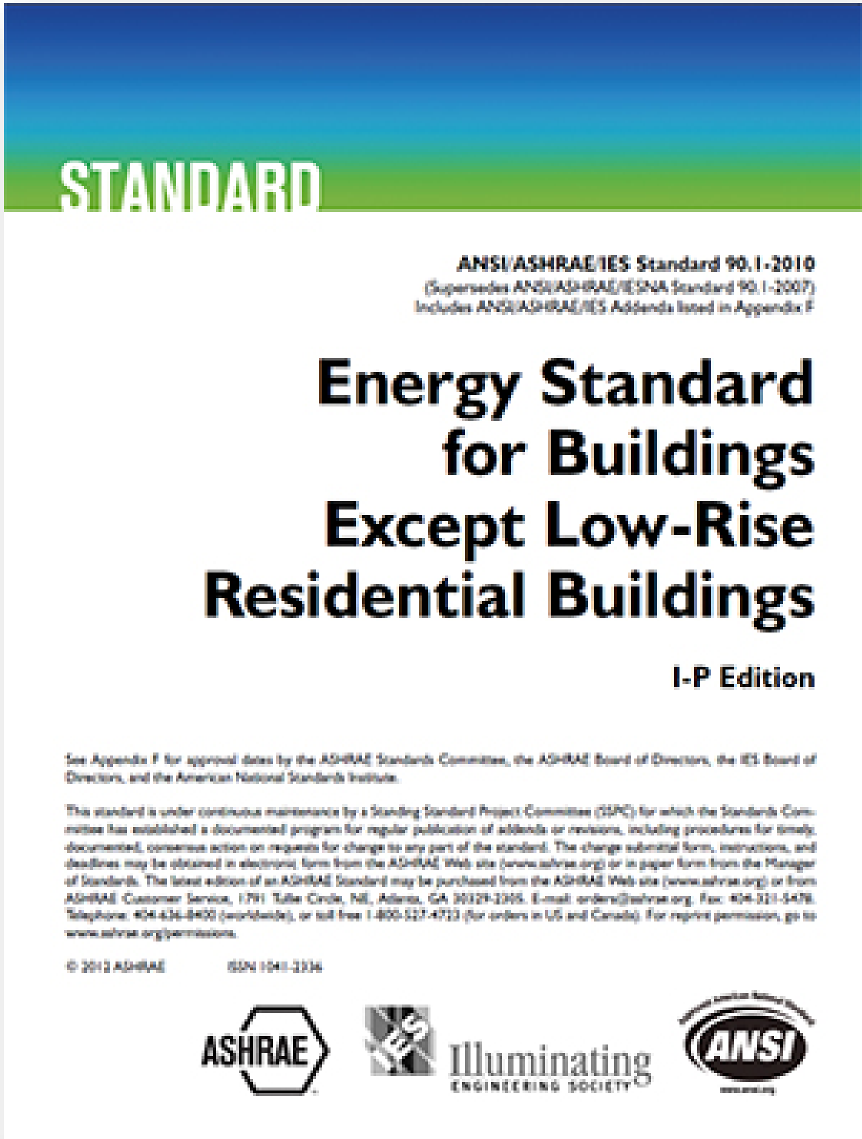
- **Natural Ventilation Procedure.** The prescriptive design procedure presented in Section 6.4, in which outdoor air is provided through openings to the outdoors, shall be per- mitted to be used for any zone or portion of a zone in con- junction with mechanical ventilation systems in accordance with Section 6.4.

ANSI/ASHRAE Standard 62.2-2016 Ventilation and Acceptable Indoor Air Quality in Residential Buildings

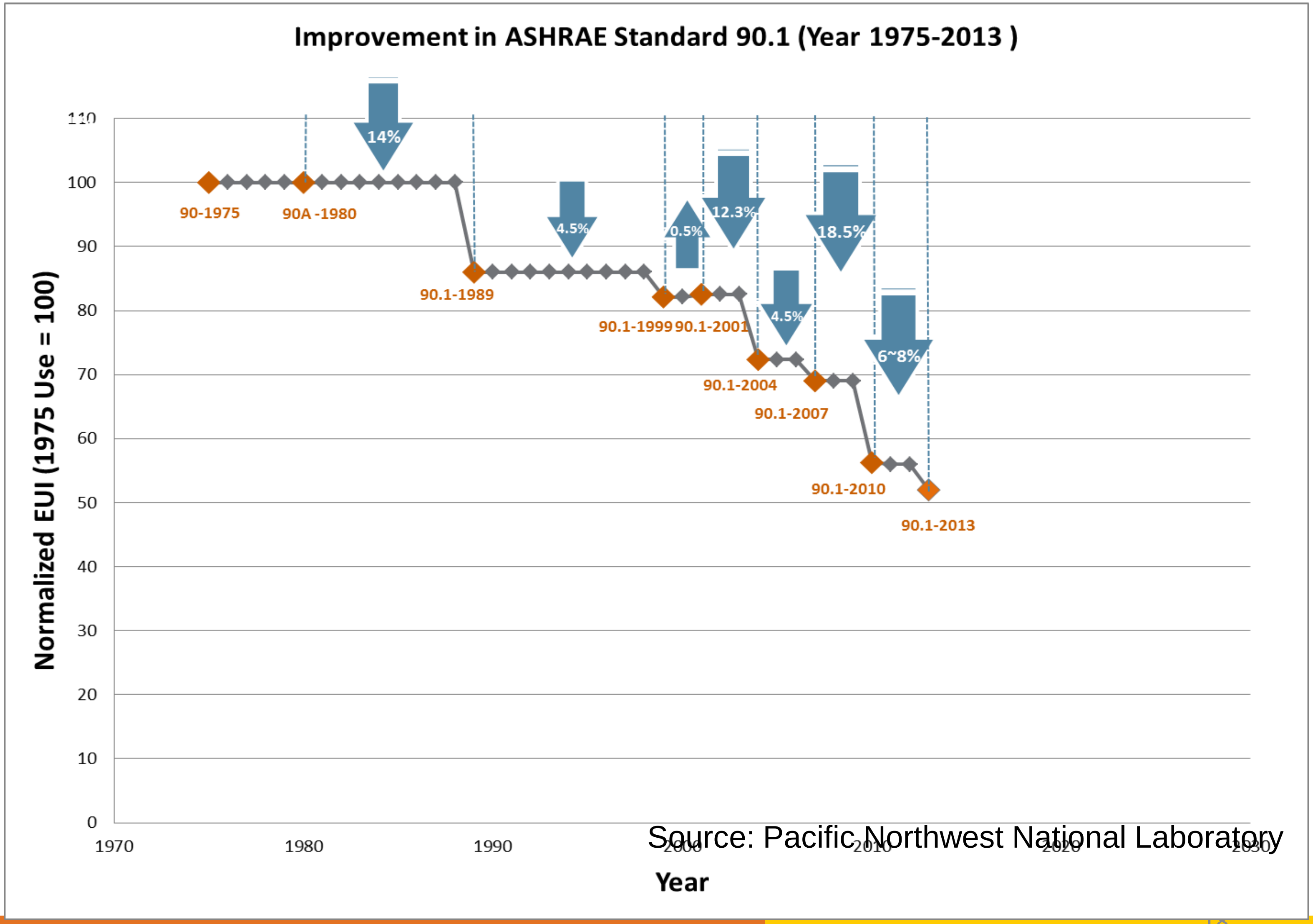
- While acceptable IAQ is the goal of this standard, it will not necessarily be achieved even if all requirements are met
- ***acceptable indoor air quality:*** air toward which a substantial majority of occupants express no dissatisfaction with respect to odor and sensory irritation and in which there are not likely to be contaminants at concentrations that are known to pose a health risk.

ASHRAE Standard 90.1-2016, *Energy Standard for Buildings Except Low-Rise Residential Buildings*

- Standard 90.1 is a benchmark for commercial building energy codes
- ASHRAE has set forth efforts to address plug load reduction and help design teams account for them when evaluating building loads with Standard 90.1
- “Regulated loads” are no longer included in a summary of energy savings in the Standard 90.1 revision in 2016
- Plug loads will continue to be a critical component in achieving Advanced Energy Design Guides



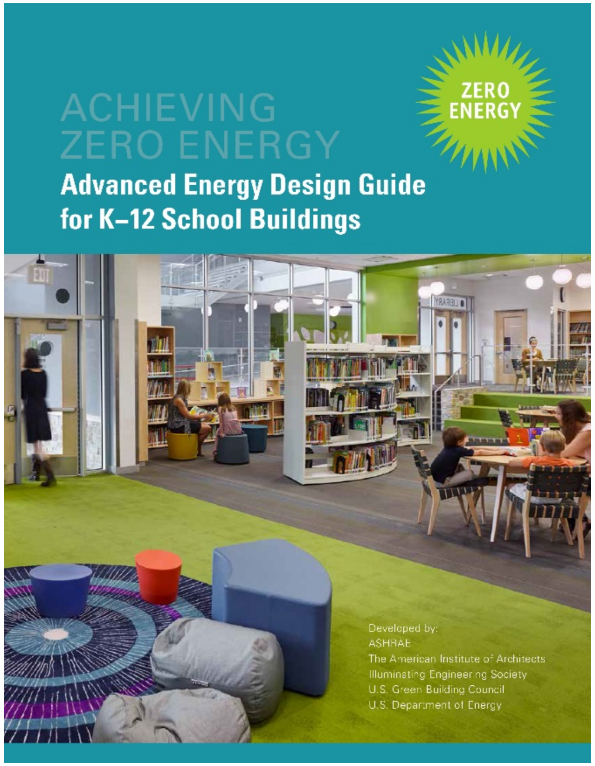
ANSI/ASHRAE/IES Standard 90.1-2013 -- Energy Standard for Buildings Except Residential Buildings



ASHRAE Standard 189.1-2014, *Standard for the Design of High-Performance Green Buildings*

- Standard 189.1 provides total building sustainability guidance for designing, building and operating high-performance green buildings
- Has broader scope than Standard 90.1
- Partners with the International Code Council (ICC) for the International Green Construction Code (IgCC)
- Single resource on green buildings "IgCC powered by 189.1" to be published in summer 2018

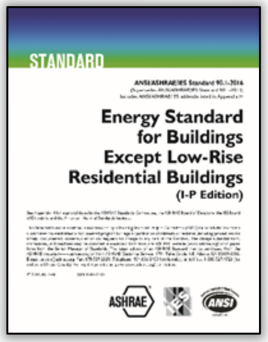
Advanced Energy Design Guide for K-12 School Buildings

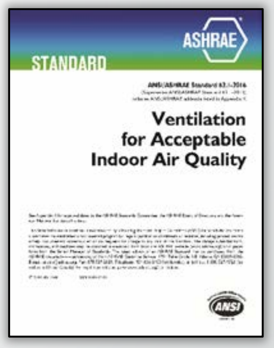


- Achieving zero energy is a driving force for ASHRAE
- New AEDG for Zero Energy K-12 Schools
- Prepared under ASHRAE special project 139
- First in a series for achieving zero energy and tailored to the design and creation of zero energy schools

Recent Publications

- Duct Fitting Database v. 6.00.05
- Standard 90.1-2016
- Standard 15/34-2016
- Standard 55 User's Manual
- Standard 55 - 2017
- Standard 62.1 User's Manual
- Standard 62.2 User's Manual
- Weather Data Viewer v. 6.0 DVD
- ASHRAE Design Guide for Dedicated Outdoor Air Systems





Further New Publications

- ASHRAE GreenGuide, 5th edition
- ASHRAE Design Guide for Cleanrooms
- ASHRAE Design Guide for Duct Systems
- ASHRAE Design Guide for Air Terminal Units
- ASHRAE Design Guide for Sustainable Refrigeration Facilities and Systems
- Advanced Energy Design Guide for K-12 (Achieving Zero Energy)
- New International Green Construction Code (IGCC)
  - ANSI/ASHRAE/ICC/USBC/IES Standard 189.1, *Standard for the Design of High-Performance, Green Buildings* is the technical basis
  - Early to mid 2018

Thank You

To Join or Renew - www.ashrae.org/join

To Get More Involved - www.ashrae.org/volunteer

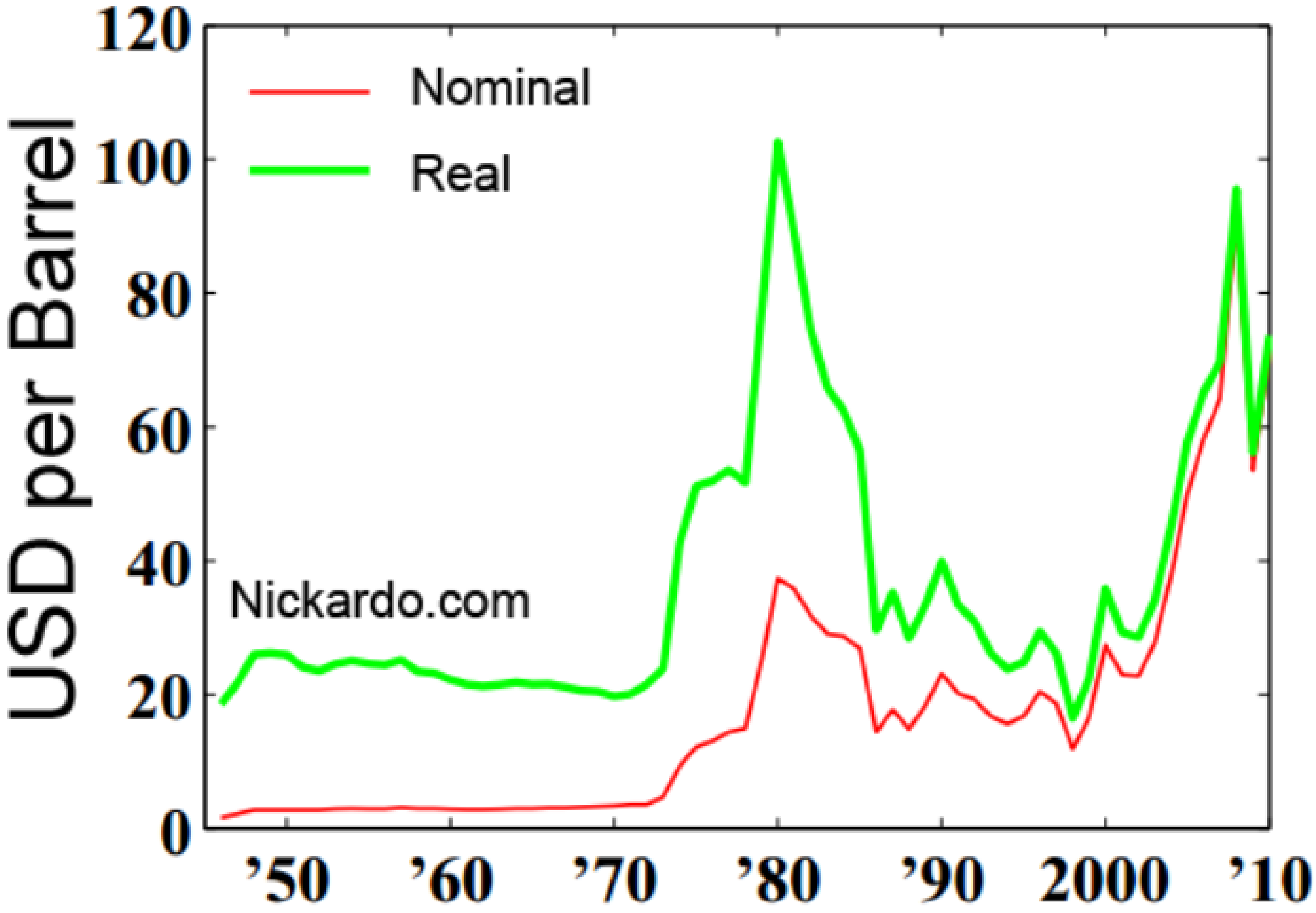
Overview of the AIVC activities

Peter Wouters – Operating Agent AIVC

Sydney - 23 March 2018

4 November 1973 - First oil crisis

Price of Oil



USD per Barrel
120
100
80
60
40
20
0
'50
'60
'70
'80
'90
2000
'10
Nominal
Real
Nickardo.com

…1975…

- Start of IEA implementing agreement **ECBCS**:

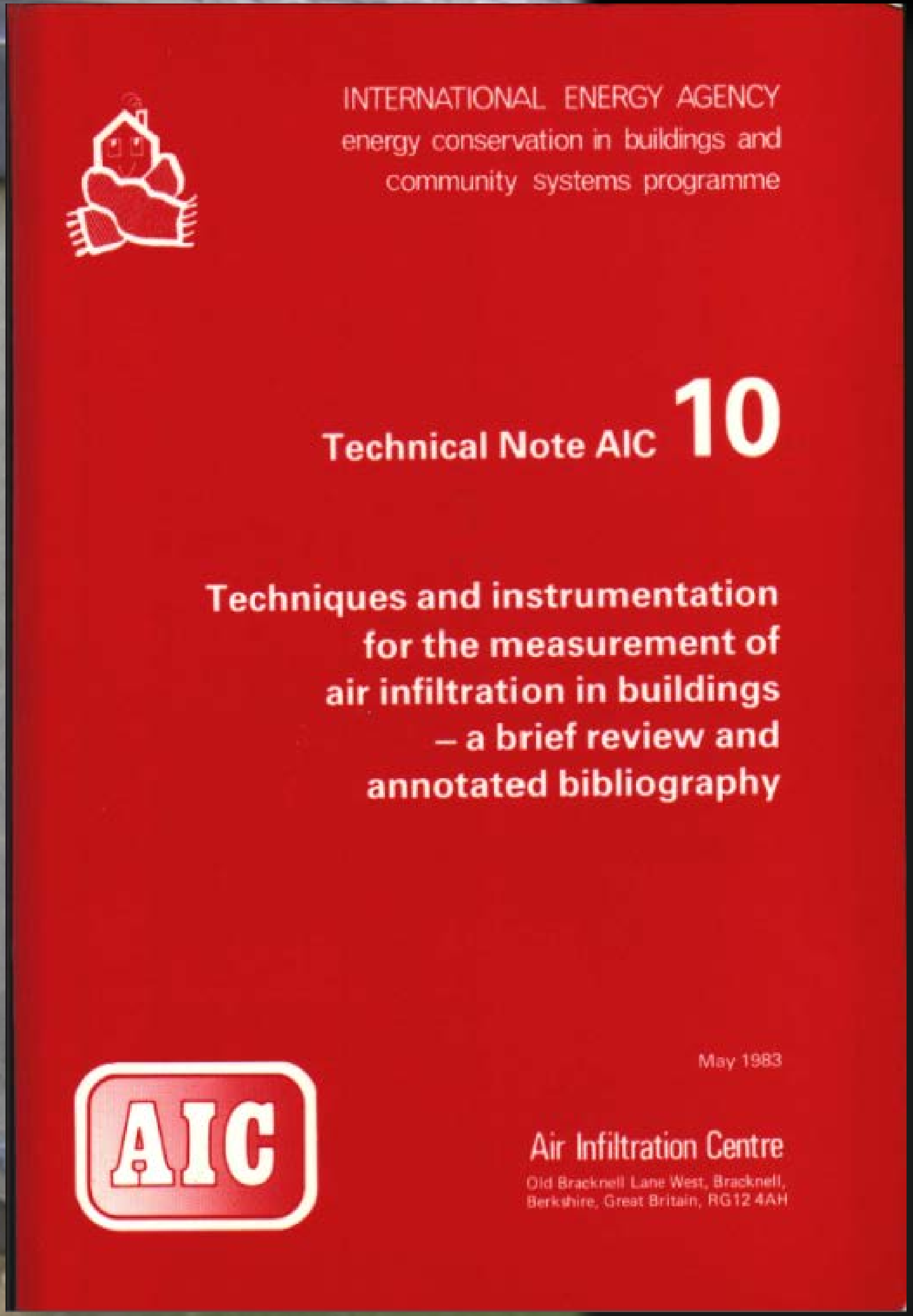
  “Energy conservation in Buildings and Community Systems”

- Most countries: limited interest and almost no knowledge on ventilation, air infiltration and indoor air quality

- Few countries were ahead: Sweden, Canada, Netherlands, …

…1980…

- ECBCS **AIC** (Air Infiltration Centre – Annex 5) running
  → Annex 1 had indicated that many questions existed regarding air infiltration
- Policy in several countries: Built tight! (no concern about IAQ)
- Airtightness was research topic in some countries
- IEA annex 8 Occupants' behaviour
- IEA Annex 18 Demand Controlled Ventilation
- In research and in some countries growing interest for health and comfort



INTERNATIONAL ENERGY AGENCY
energy conservation in buildings and
community systems programme

Technical Note AIC 10

Techniques and instrumentation
for the measurement of
air infiltration in buildings
– a brief review and
annotated bibliography

May 1983

AIC

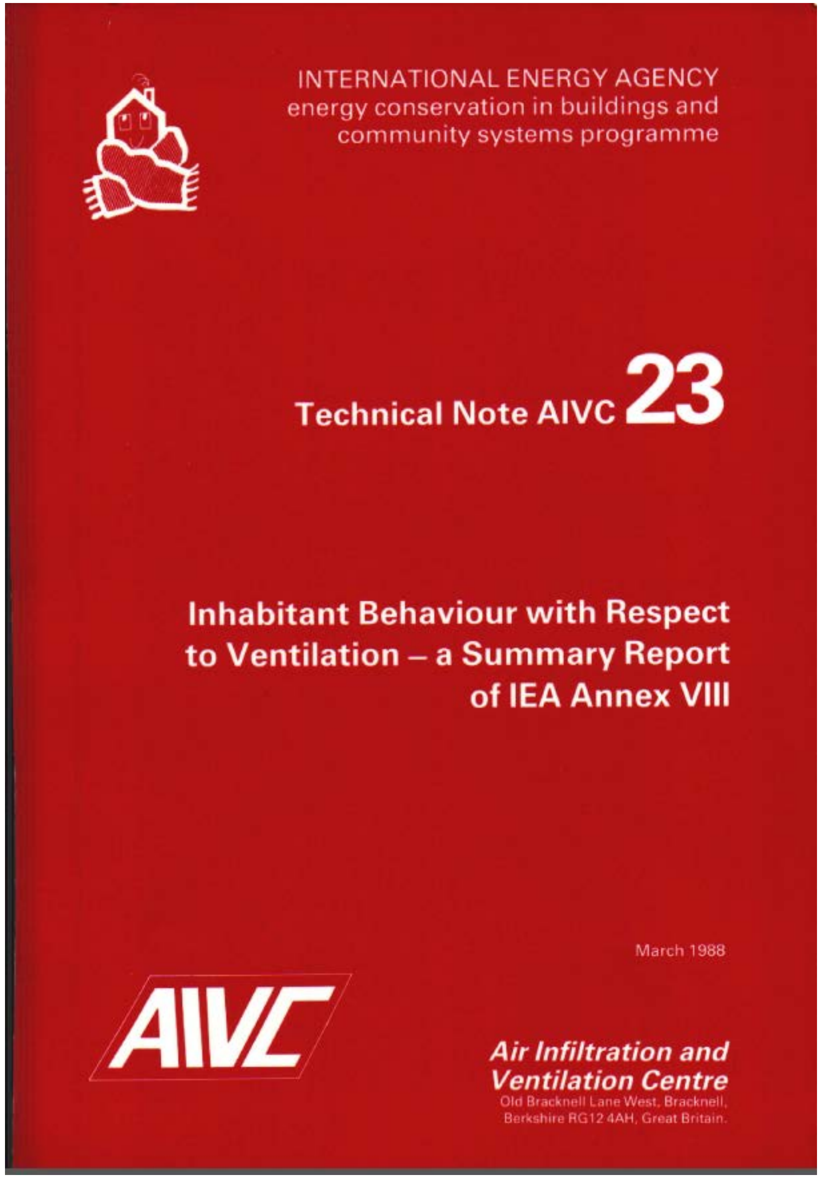
Air Infiltration Centre
Old Bracknell Lane West, Bracknell,
Berkshire, Great Britain, RG12 4AH

1986

AIC became **AIVC**

The **'Air Infiltration and Ventilation Centre'**

Annex 8



INTERNATIONAL ENERGY AGENCY
energy conservation in buildings and
community systems programme

Technical Note AIVC 23

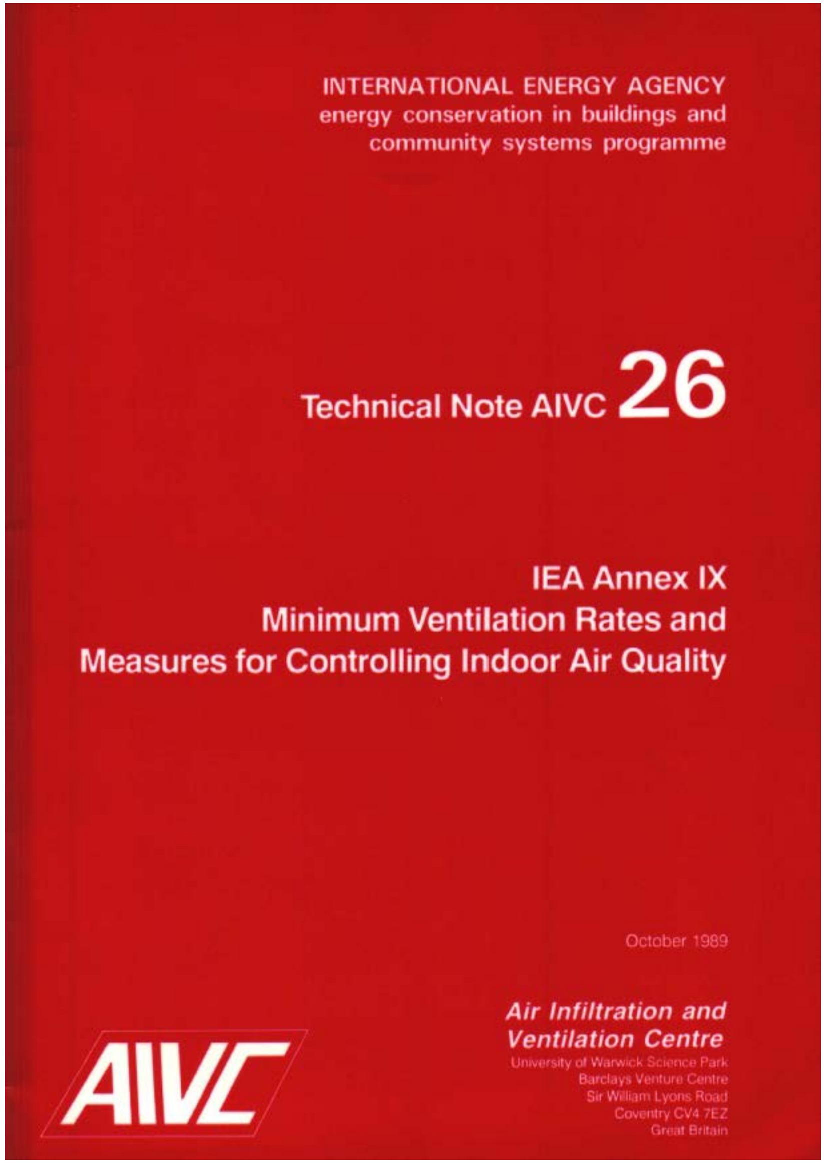
Inhabitant Behaviour with Respect
to Ventilation – a Summary Report
of IEA Annex VIII

March 1988

AIVC

Air Infiltration and
Ventilation Centre
Old Bracknell Lane West, Bracknell,
Berkshire RG12 4AH, Great Britain.

Annex 9



INTERNATIONAL ENERGY AGENCY
energy conservation in buildings and
community systems programme

Technical Note AIVC 26

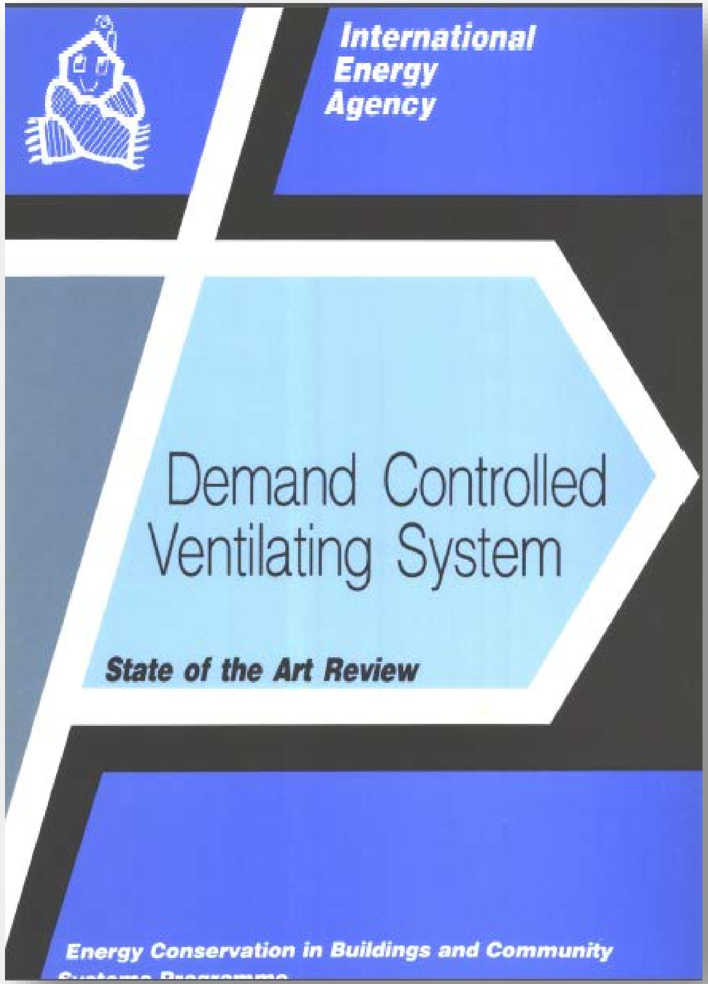
IEA Annex IX
Minimum Ventilation Rates and
Measures for Controlling Indoor Air Quality

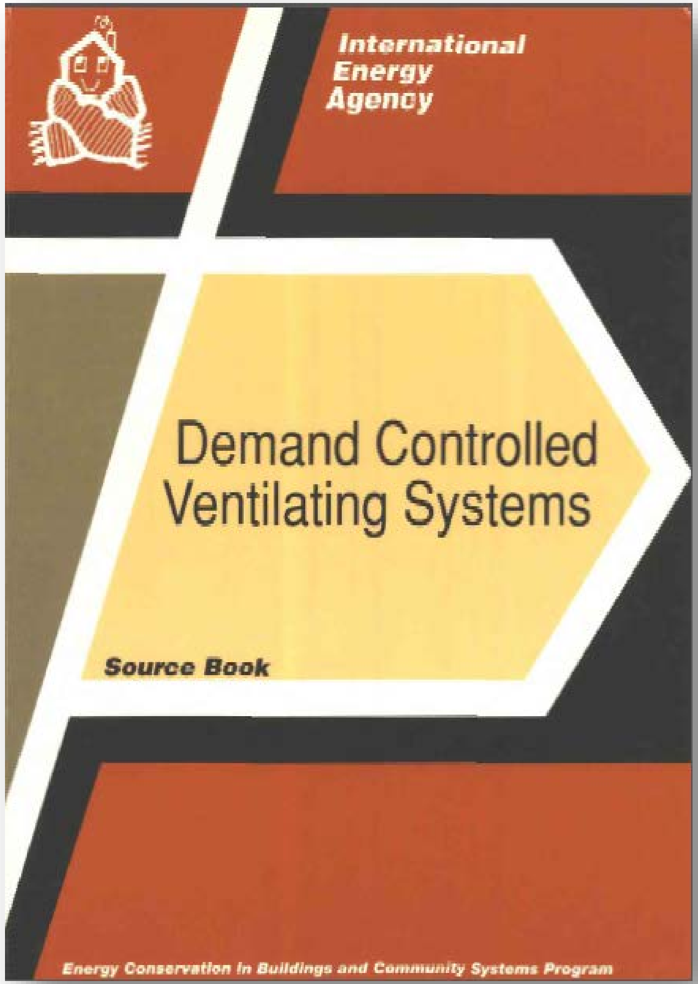
October 1989

AIVC

Air Infiltration and
Ventilation Centre
University of Warwick Science Park
Barclays Venture Centre
Sir William Lyons Road
Coventry CV4 7EZ
Great Britain

IEA EBC Annex 18
Demand Controlled Ventilation Systems
(1987-1992)

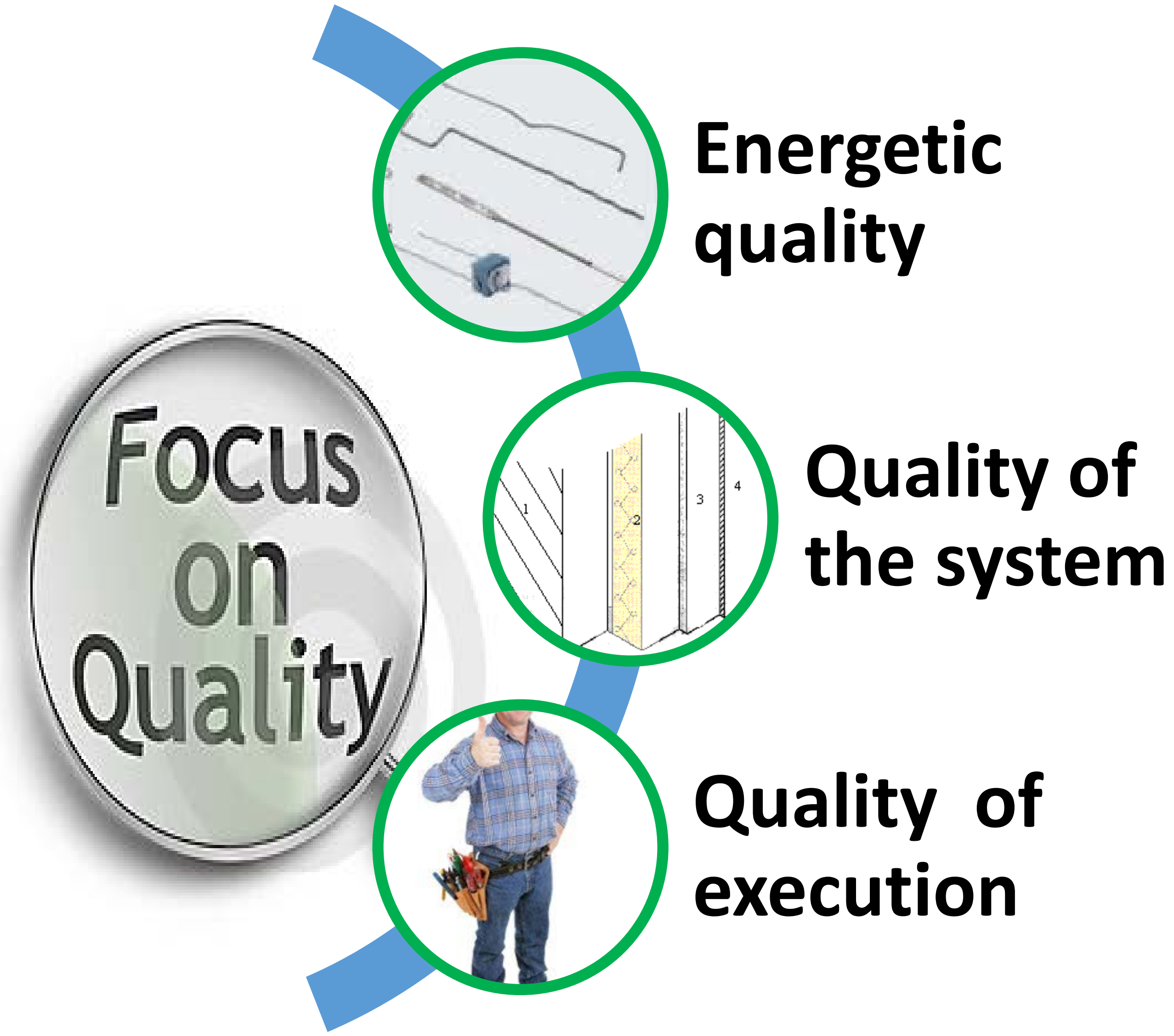


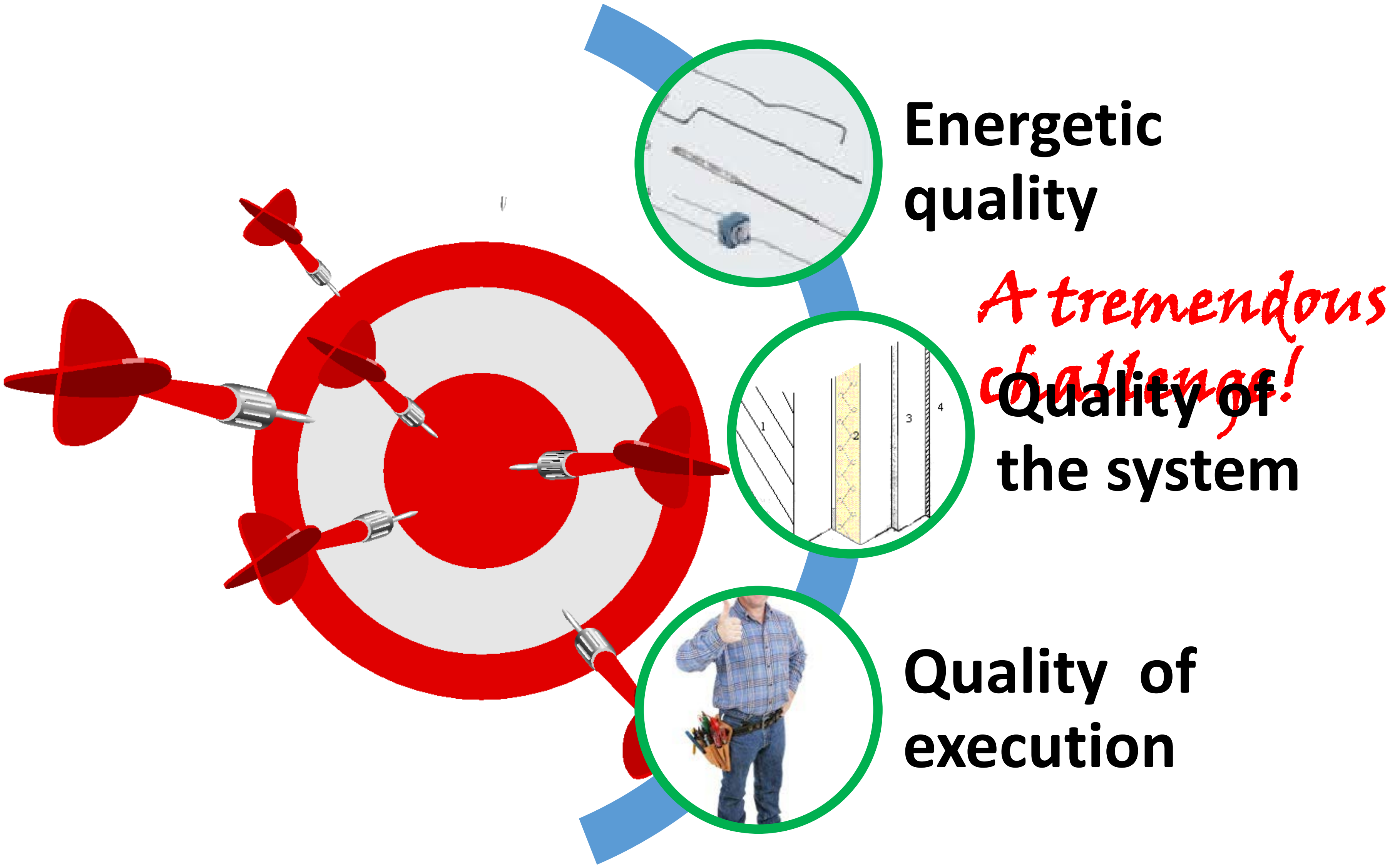


Today (…2018…)

- Towards nearly-zero energy buildings
- Millions of airtightness measurements
- Concerns about quality of ventilation systems and workmanship


Solutions
N
IN OVATION


Focus on Quality
Energetic quality
Quality of the system
Quality of execution


Energetic quality
A tremendous challenge!
Quality of the system
Quality of execution

International collaboration
International events
...


Lessons Learned
recognize mistakes
observe what works
document them
share them

LOGIN

EBC

Energy in Buildings and Communities Programme

Search

Home About AIVC Countries Events Resources Links FAQ Contact us

Airbase | AIVC Newsletters | AIVC Publications | AIVC Events

Recent News

Highlighted News

AIVC 2018 Conference - Abstract submission...

New deadline is 20 March, 2018

> 02 March 2018 MORE

Register now for the AIVC webinar on smart...

6-March-2018, 15:00-16:30 (CET)

> 01 February 2018 MORE

23 Mar-18 - AIVC Workshop "Ventilation for...

Sydney, Australia

> 15 January 2018 MORE

AIRBASE Click here for searching in a database of 22279 publications with 15778 pdf documents

Top events

6 March 2018, Webinar – IAQ sensors for smart ventilation of buildings

AIVC defines smart ventilation as a process to continually adjust the ventilation system of a building in order to provide the desired Indoor Air Quality (IAQ) benefits while minimizing energy consumption, u

MORE

19-20 March 2018, Workshop, Wellington (NZ) - Towards higher-performing buildings: The role of airtightness...

The objective of this AIVC workshop is to discuss and identify ways to improve the quality of our homes with respect to airtightness and ventilation, as well as discussing the impact suboptimal performance h

MORE

18-19 September 2018, Conference, Juan-les-Pins, 39th AIVC conference

The 39th AIVC conference: "Smart ventilation for buildings" will be held on 18 and 19 September 2018 in Juan-les-Pins, France.

Did you know?

What is Ventilation Efficiency?

LEARN MORE

Key Publications

VIP 37: Impact of Energy Policies on...

This Ventilation Information Paper analyses both the policy instruments used (...

> Valérie Leprince, Maria Kapsalaki, Rémi Carrié, EU

MORE

VIP 36: Metrics of Health Risks from...

In a recent review of 31 green building certification schemes used around the...

AIVC Member countries

- Belgium
- China
- Denmark
- France
- Italy
- Japan
- Korea
- Netherlands
- New Zealand
- Norway
- Spain
- Sweden
- United Kingdom
- United States

→ **Interest from several other countries**

More focusing on
market implementation

TightVent® Europe

BUILDING AND DUCTWORK AIRTIGHTNESS PLATFORM

AIVC

More focusing on knowledge
generation aspects

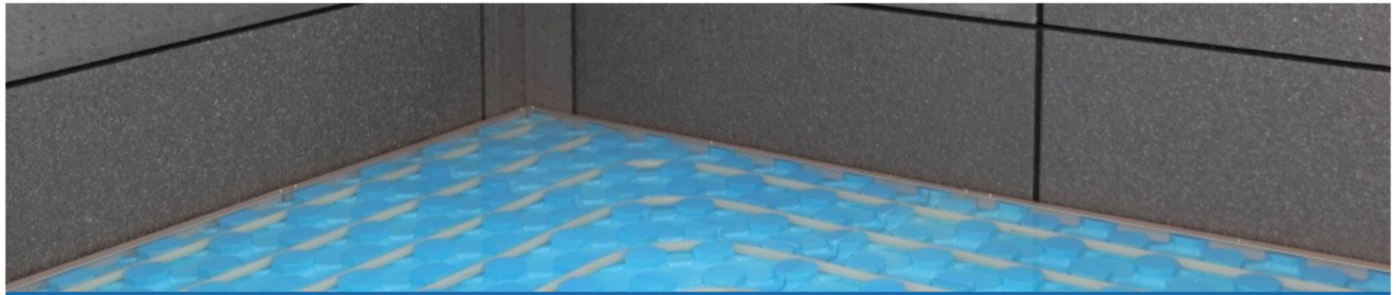
More focusing on
market implementation

venticool

the international platform for ventilative cooling

IEQ Global Alliance

For better indoor environment quality



IEQ-GA

Mission of the IEQ Global Alliance

The mission of IEQ-GA is to provide an acceptable indoor environmental quality (thermal environment-indoor air quality-lighting-acoustic) to occupants in buildings and places of work around the world and to make sure the knowledge from research on IEQ get to be implemented in practice. >> Read more...

Keynote speakers at the 38th AIVC – 4th venticool – 6th TightVent joint conference

AIVC

The keynote speakers for the 38th AIVC – 6th TightVent – 4th venticool conference: "Ventilating healthy low-energy buildings" have been announced. The joint conference, co-organized by the International Network on Ventilation and Energy Performance (INIVE), on behalf of the Air …

Continue reading →

User's Manual for 2016 IAQ Standard Published by ASHRAE

ASHRAE

ATLANTA – A manual to help users navigate the changes in ASHRAE's 2016 ventilation standard is now available. The User's Manual for ANSI/ASHRAE Standard 62.1-2016, Ventilation for Acceptable Indoor Air Quality, provides information on the requirements of the standard and …

Continue reading →

REHVA Journal issue 6 / December 2016

REHVA Federation of European Heating,

The REHVA Journal December issue on **EPB Standards Published for Formal Vote** & **Energy Efficient Renovations** is now available online @ www.rehva.eu

Annual AIVC conferences | AIVC Workshops | AIVC Webinars | Events endorsed by AIVC

Workshop details

14-15 March 2017, Workshop, Brussels - Is ventilation the answer to indoor air quality control in buildings? Do we need performance-based approaches?

Brussels, Belgium 03/14/2017 - 09:15

Indoor exposure to contaminants should be minimized to avoid adverse health and comfort effects. Experience shows that this qualitative statement is difficult to translate into measurable terms, such as performance indicators or metrics, which can be used as a basis for defining and assessing requirements in regulations and standards while holistically reflecting indoor air quality. The simplest and most commonly used approaches rely on ventilation airflow rates determined by experts or codes. These approaches have fundamental shortcomings in practice for systems that do not have steady contaminant sources or do not provide a constant airflow rate, such as natural, hybrid, or demand-controlled ventilation. More sophisticated approaches can be based on health damage, pollutant exposures, or perceived air quality but they generally entail a number of assumptions about the pollutants of concern and occupant scenarios. Such methods could lead to useful metrics. However, as of today, there is no clear set of metrics that can be used to assess the overall ventilation performance of a building with regard to its indoor air quality, or used in standards or regulations.

This workshop aims to identify the pros and cons of performance-based approaches and metrics that can be considered to assess the IAQ performance of ventilation systems, as well as to draft guidelines for their use in standards and regulations.

Ventilating healthy low-energy buildings

Smart ventilation for buildings

V entilation
I nformation
P aper
n° 38

March 2018

Operating Agent
and Management
Boulevard Poincaré 79
B-1060 Brussels – Belgium
inive@bbri.be - www.inive.org

International Energy Agency
Energy Conservation in Buildings
and Community Systems Programme

Air Infiltration and Ventilation Centre

What is smart ventilation?

François Durier, CETIAT, France
Rémi Carrié, ICEE, France
Max Sherman, LBNL, USA

Topical sessions at 2018 conference …

1. IAQ metrics
2. Smart ventilation control
3. Sensors for smart ventilation
4. Rationale behind ventilation requirements and regulations
5. Utilization of heat recovery
6. Integrating uncertainties due to wind and stack effect in declared airtightness results
7. Ductwork airtightness
8. Residential cooker hoods
9. French initiatives for indoor air quality
10. Demand controlled ventilation in French buildings – 35 years of wide scale experience
11. Commissioning of ventilation systems – Improving quality of installed ventilation systems
12. Measurement Accuracy of air flow and pressure difference
13. Air cleaning as supplement for ventilation
14. New annex on resilient cooling
15. BIM and Construction 4.0 opportunities in relation to ventilation and airtightness

Workshops in Wellington and Sydney

130 inscriptions

19-20 March 2018, Workshop, Wellington (NZ) - Towards higher-performing buildings: The role of airtightness and ventilation

Wellington, New Zealand 03/19/2018 - 08:00

23 March 2018 Workshop Sydney (Australia) – Ventilation for IAQ and cooling

Topical sessions at 2018 conference …

1. **IAQ metrics**
2.
3.
4.
5. Utilization of heat recovery
6. Integrating uncertainties due to wind and stack effect in declared airtightness results
7. Ductwork airtightness
8. Residential cooker hoods
9. French initiatives for indoor air quality
10. Demand controlled ventilation in French buildings – 35 years of wide scale experience
11. Commissioning of ventilation systems – Improving quality of installed ventilation systems
12. Measurement Accuracy of air flow and pressure difference
13. Air cleaning as supplement for ventilation
14. New annex on resilient cooling
15. BIM and Construction 4.0 opportunities in relation to ventilation and airtightness

Max Sherman:

Why do we care about IAQ Metrics?

Topical sessions at 2018 conference …

1. IAQ metrics
2. Smart ventilation control
3. Sensors for smart ventilation
4. Rationale behind ventilation requirements and regulations
5. Utilization of heat recovery
6. Integrating uncertainties due to wind and stack effect in declared airtightness results
7. Ductwork **airtightness**

Willem de Gids:

Measuring airtightness of dwelling with a domestic ventilation system

11. Commissioning of ventilation systems – Improving quality of installed ventilation systems
12. Measurement Accuracy of air flow and pressure difference
13. Air cleaning as supplement for ventilation
14. New annex on resilient cooling
15. BIM and Construction 4.0 opportunities in relation to ventilation and airtightness

Topical sessions at 2018 conference …

1. IAQ metrics
2. Smart ventilation control
3. Sensors for smart ventilation
4. Rationale behind ventilation requirements and regulations
5. Utilization of heat recovery
6. Integrating uncertainties due to wind and stack effect in declared airtightness results
7. Ductwork airtightness
8. Residential cooker hoods
9. French initiatives for indoor air quality
10. Demand controlled ventilation in French buildings – 35 years of wide scale experience
11. **Commissioning of ventilation systems – Improving quality of installed ventilation systems**

Peter Wouters:

Ventilation and airtightness: European experiences of on-site performances and approaches for improvement

AIVC Newsletter

http://subscriptions.inive.org/

Monthly newsletter

News.inive.org

Energy Efficiency and Indoor Climate in Buildings

... with specific information on AIVC, IEQ-GA and the platforms QUALICHeCK, Dynastee, venticool and TightVent

AIVC 2018 Conference - Abstract submission deadline extended

Shared by
INIVE eeig

aivc.org - The abstract submission deadline for the 39th AIVC - 7th TightVent - 5th venticool joint conference "Smart ventilation for buildings" to be held on 18 and 19 September 2018 in Antibes Juan-Les-Pins, ...

SAVE THE DATE for our upcoming webinar on ventilative cooling – 25 April 2018, 10:30-12:00 (CET)

Shared by
venticool

venticool.eu - The FREEVENT project and venticool are organising the webinar: "Ventilative cooling and summer comfort: Freevent project in France" to be held on Wednesday 25 April at 10:30 AM (CET). The programme i...

AIVC Workshop on airtightness & ventilation, 19-20 March 2018, Wellington, NZ

Shared by
INIVE eeig

tightvent.eu - New Zealand homes and apartments have become more and more airtight and have reached a level of airtightness that requires dedicated ventilation. Despite the fact that there is no airtightness requir...

23 Mar-18 - AIVC Workshop "Ventilation for IAQ and cooling"

Shared by
INIVE eeig

aivc.org - The AIVC (Air Infiltration and Ventilation Centre) and the Cooperative Research Centre (CRC) for Low Carbon Living warmly invite you to participate in a free, one-day workshop Ventilation for Indoor ...

AIVC Workshop on airtightness & ventilation, 19-20 March 2018, Wellington, NZ

Shared by
INIVE eeig

tightvent.eu - New Zealand homes and apartments have become more and more airtight and have reached a level of airtightness that requires dedicated ventilation. Despite the fact that there is no airtightness requir...

China joins the AIVC

Shared by
INIVE eeig

aivc.org - The AIVC is very pleased to welcome China as new participating country! China will be represented in the AIVC board by Guoqiang Zhang, Dean of Institute of Sustainable

Subscribe to the Email Newsletter

enter your email address | Subscribe

INIVE eeig

INIVE EEIG – International Network for Information on Ventilation and Energy Performance

Editor's note

Dear Reader,

We wish you a healthy 2018!
With this monthly information paper on energy efficiency and indoor climate, we hope to keep you informed about new interesting information on the internet.

In addition, it provides information related to several specific areas of interest:
- Activities with a link to the Air Infiltration and


Indoor air quality
Ventilation
Comfort
Airtightness

LOW CARBON LIVING CRC

Evaluation & Future Direction of Next Generation Automated FDD Tools in Australia

Dr Josh Wall, CSIRO

Summary

- What is FDD & can it help ventilation?
- Overview of RP1026: *Evaluation of Automated FDD Solutions*
- FDD Case Study Results in AU
- Future Direction

Automated FDD Solutions

- WHAT IS FDD?
  - FDD is an area of investigation concerned with automating the processes of detecting faults within building systems and diagnosing their causes (Katipamula & Brambley 2005).

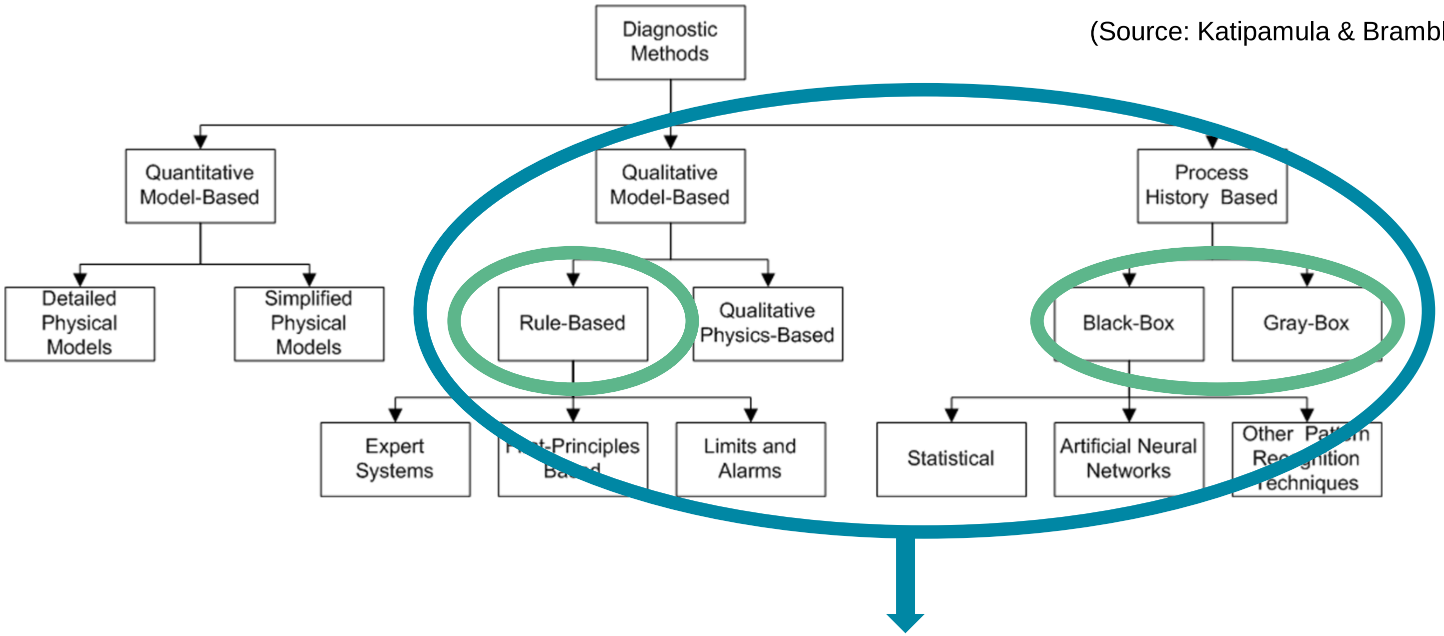
  - Software based (rules / algorithms)
  - Intelligent analytics to detect, diagnose and quantify operational inefficiencies.
    - Short-term 'abrupt' faults with systems or equipment
    - Longer-term performance degradation faults and energy wastage

Automated FDD Solutions

- Gen I FDD Tools:
  - Stand-alone software tools. Largely ‘Rule-Based’
  - Target Users: Facility Manager / Building Operator
  - Significant implementation effort & tuning
  - Downfalls: False alarms and ‘alarm fatigue’
- Gen II FDD Tools:
  - Managed Software as a Service (SaaS)
  - Rule-Based + Machine Learning-Based
  - Target Users: + O&M Contractors, BMS Controls Contractors, Building & Portfolio owners, Tenants
  - Better integration into O&M workflows

LOW CARBON LIVING CRC

Classification of FDD Methods



(Source: Katipamula & Brambley, 2005)

- Hybrid Approach?
  - Rule-Based
  - Black-Box / Grey-Box
  - Baselining + Predictive Maintenance

RP1026 Overview

- RP1026 (Program 1: Integrated Building Systems):
  - *"Evaluation of Next-Generation Automated Fault Detection & Diagnostics (FDD) Tools for Commercial Building Energy Efficiency"*
  - Scope: … A systematic independent evaluation of the potential benefits of automated FDD solutions delivered as a managed service in Australia.
  - *Focus on FDD for HVAC Systems in commercial blds*
    - Part I: FDD Case Studies in Australia (publically available)
    - Part II: FDD Objective evaluation in an exemplar trial building (confidential)

RP1026 – Final Report

- Hot off the press!

"FDD Case Studies in AU"

RP1026 Scope

- Independent evaluation:
  - Commercially available solutions in AU market
  - Solution Delivered as a ‘Managed Service’
- 6 FDD Solution Providers
  - CIM Enviro | Coppertree Analytics | Schneider Electric | UCTriX | Synengco | Control & Electric
- 7 different FDD Case Studies across AU
  - Mix of commercial building types (office, lab, museum, hospital)
  - Locations: NSW, ACT, QLD, VIC

RP1026 Scope

- Types of ‘Faults / Alarms / Insights detected:
  - Sensor faults (bias, drift, malfunction)
  - Equipment faults
    - Central plant faults (staging, pressure, not meeting SP)
    - Water values & air dampers stuck open/closed
    - Oscillating water values
    - Incorrectly tuned control loops
    - Fan motor / VSD faults / belt ware and slippage
    - Air filter blockages and duct leakages
  - System / Sub-system faults or inefficient operation
  - Anomaly detection & energy wastage

LOW CARBON LIVING CRC

What FDD end users are saying:

"*Using CIM Enviro, we have achieved a seven half-star jump for $48,000 Opex, but most impressively, for no Capex expenditure* "

- Associate Director | Asset Management, NSW

"*The introduction of Synengco FDD for at our hospital site will enable us to use predictive techniques to proactively manage our energy usage.*"

- Facilities Maintenance Manager, QLD

"*The Joule AnalytiX platform integrates with our existing BMCS and helps us get the most from our contractors.*"

- Operations Manager, NSW

"*Building Analytics by Schneider Electric has helped us improve our proactive maintenance program of critical assets enabling us provide a high level of service to our customers*"

- Mechanical Asset Manager, VIC

" *Coppertree Analytics has been an integral part in driving our maintenance activities and lowering our energy consumption.*
It's implementation has helped streamline our maintenance, which means more time can be spent fixing problems instead of identifying them."

- Senior Building Manager, ACT

RP1026 FDD Case Study Results

- Summary of Key Results

	Case study Project:	Key FDD Outcomes:
	Melbourne Museum, Melbourne VIC	Yearly savings of 20% in electricity and 28% in gas
	Commercial Office Tower, Sydney NSW	1.5 Star to 5 Star NABERS rating in 24 months
	Commercial Office Tower, Canberra ACT	Improved thermal comfort conditions while achieving 15% total electricity reduction and 19% total gas reduction
	Melbourne Airport, Melbourne VIC	Reduction in the avoidable energy cost, number of comfort anomalies, and number of maintenance anomalies
	Public Hospital, Brisbane QLD	Decisions-support to reduce the life cycle cost of operation, and aided electricity, gas and facility management contract negotiations
	Research Lab Facility, Canberra ACT	20% decrease in monthly energy consumption and 744MJ/m^2 decrease in site energy intensity

- Full Results (Final Report):

  RP1026: Evaluation of Next-Generation Automated Fault Detection & Diagnostics Tools for Commercial Building Energy Efficiency

What FDD Solution Features to look for?

(based on Clarke et al., 2015)

- Does it provide a real-time multi-user interface as well as periodic reporting for delivery of actionable insights?
- Can it integrate and utilise BMCS data, energy/power sub-meter data, and other building and external systems data?
- Can it pinpoint the source of failure at the sub-system or equipment level?
- What are the upfront and ongoing costs, and are there any extra or hidden costs?
- What data and information is required to fully implement the solution and what is the setup time?
- Can it integrate with maintenance processes and work-order systems to remove manual handling and data entry to fast-track rectification works?

Future Directions

- Emerging AI and machine learning tools + large amounts of data from disparate data sources
- Analysed in a way that provides meaningful insights into the short + longer term performance (and degradation) of all Building Energy Systems!
  - Data Sources: BMCS, sub-metering, localised high resolution weather data, building occupancy & preference, thermal comfort, building information models (BIM), commissioning data
- Accurate Predictive Maintenance outcomes
  - Estimate remaining time to failure (or time before reaching an unacceptable level of performance)
  - Rate of degradation
  - Nature of the failure if it were to occur

Conclusion

- Latest Generation FDD Tools & Services are demonstrating enormous value
  - Energy / cost / ratings / equipment life
  - Comfort & satisfaction (IAQ, thermal comfort…)
- Next Gen FDD & Analytics Solutions
  - Big data, complex systems, predictive maintenance
- FDD + Ventilation?
  - Maintain high operating efficiencies for HVAC and ventilation systems & sensors
  - Detect senor errors (operation, bias, drift)
    - CO_2, IAQ, occupancy/motion detection
  - Active ventilation systems: detect faults & energy wastage
    - Exhaust fans, AHU fans, VSDs, Drive belts, air filters

KEEP VENTILATED!

Thank you

Dr Josh Wall
Research Project Leader | Intelligent Grid & Building Controls
CSIRO Energy
josh.wall@csiro.au

To find out more, contact

CRC for Low Carbon Living Ltd

Room 202-207, Level 2,
Tyree Energy Technologies Building
UNSW Sydney NSW 2052 Australia

E: info@lowcarbonlivingcrc.com.au
P: +61 2 9385 5402
F: +61 2 9385 5530

Twitter: @CRC_LCL

PARTICIPANTS

The CRC for Low Carbon Living also works with an extensive range of government and industry third parties at a project level

CONTACT US

CRC for Low Carbon Living Ltd
www.lowcarbonlivingcrc.com.au
info@lowcarbonlivingcrc.com.au

Twitter: @CRC_LCL
P: +61 2 9385 5402
F: +61 2 9385 5530

Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme

WHY DO WE CARE ABOUT…

IAQ METRICS

Max Sherman
MHSherman@lbl.gov

LAWRENCE BERKELEY NATIONAL LABORATORY, SENIOR SCIENTIST
UNIVERSITY OF NOTTINGHAM, PROFESSOR

MARCH, 2018

University of Nottingham
UK | CHINA | MALAYSIA

WHY DO WE CARE ABOUT…METRICS?

Metrics allow us to quantify an effect of interest	Metrics allow us to combine similar effects into a single measure of performance	Metrics allow us to optimize performance relative to other criteria	Metrics can be used in codes & standards
e.g. kWh is an *energy* metric	e.g. kWh & m^3 natural gas -> kg of CO_2	e.g. kg of CO_2 saved per $ invested	e.g. Max $CO_2/m^2/yr$

WHY DO WE CARE ABOUT…INDOOR AIR QUALITY?

- IAQ is generally considered to be one of the top 5 health hazards in the developed world
  - but you can't get the health service to pay for it
- IAQ is one of the services we expect our buildings to provide
  - usually through ventilation (inc. infiltration)
- IAQ is a potential barrier to effecting energy efficiency in buildings
  - Tightening reduces infiltration

WHICH IAQ EFFECTS DO WE CARE ABOUT?

1. HEALTH: THE MOST FUNDAMENTAL IAQ CRITERION IS HARM TO PEOPLE FROM INDOOR AIR
2. ACCEPTABILITY: ODOR, IRRITANCY CAN MAKE IAQ UNACCEPTABLE EVEN IF NOT UNHEALTHY
3. MOISTURE: INDIRECT EFFECT BUT CAN PROMOTE BIOLOGICAL GROWTH OR MATERIAL DEGRADATION
4. OCCUPANTS: *THE BEST LAID PLANS OF MICE AND MEN OFTEN GO AWRY*

EACH COULD HAVE ITS OWN SUB-METRIC

WE HAVE A HEALTH METRIC: DALY

Disability Adjusted Life Years (DALYs)

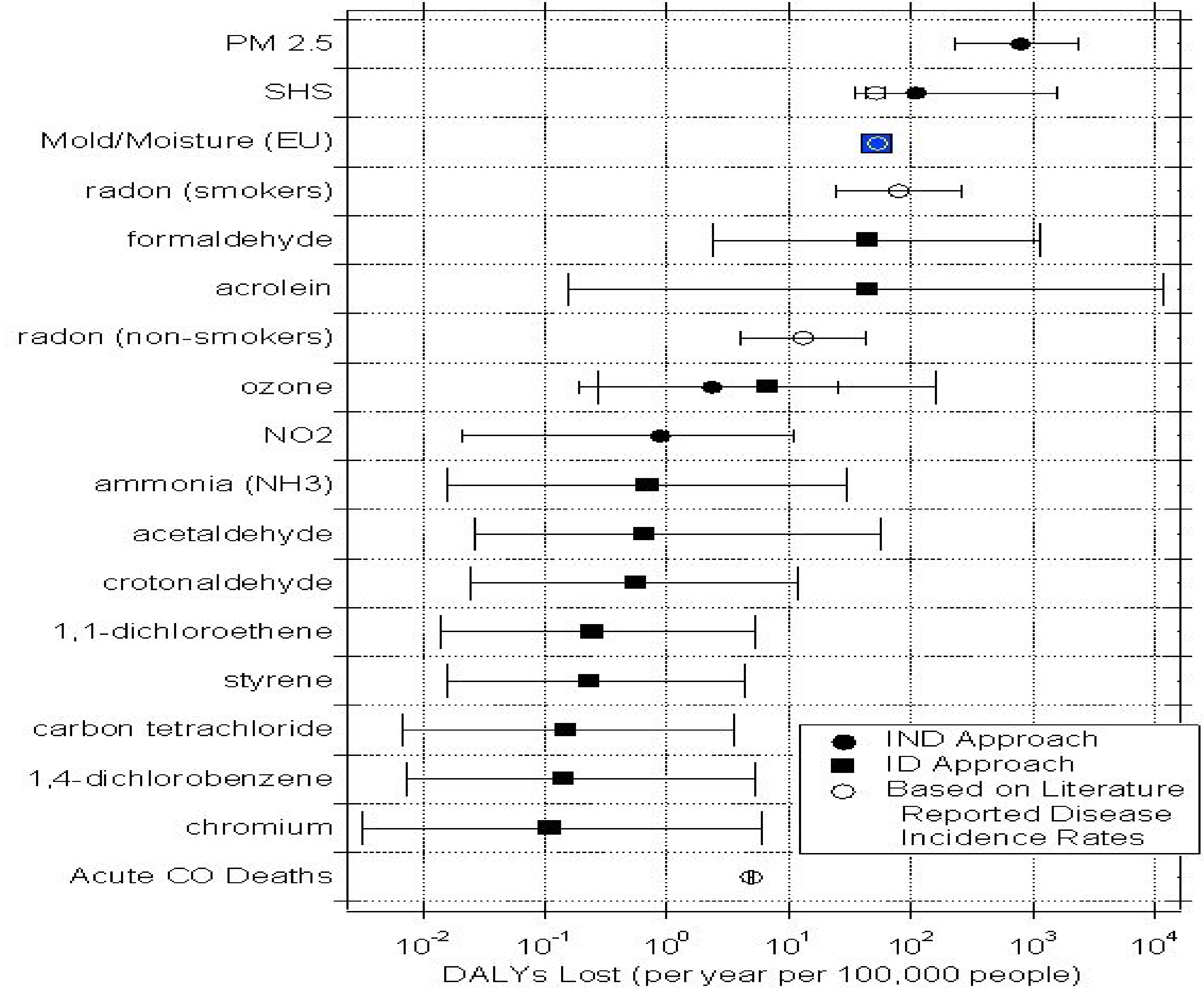
DALY=YLL+YLD

YLL = Years lost to premature death

YLD = Equivalent years lost to disability

US DALY valued at roughly $50,000 - $200,000

Non-Fatal Stroke: ~9.5–13 DALYs



PM 2.5
SHS
Mold/Moisture (EU)
radon (smokers)
formaldehyde
acrolein
radon (non-smokers)
ozone
NO2
ammonia (NH3)
acetaldehyde
crotonaldehyde
1,1-dichloroethene
styrene
carbon tetrachloride
1,4-dichlorobenzene
chromium
Acute CO Deaths
IND Approach
ID Approach
Based on Literature Reported Disease Incidence Rates
10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4}
DALYs Lost (per year per 100,000 people)

FULL IAQ METRICS IS THE GOAL

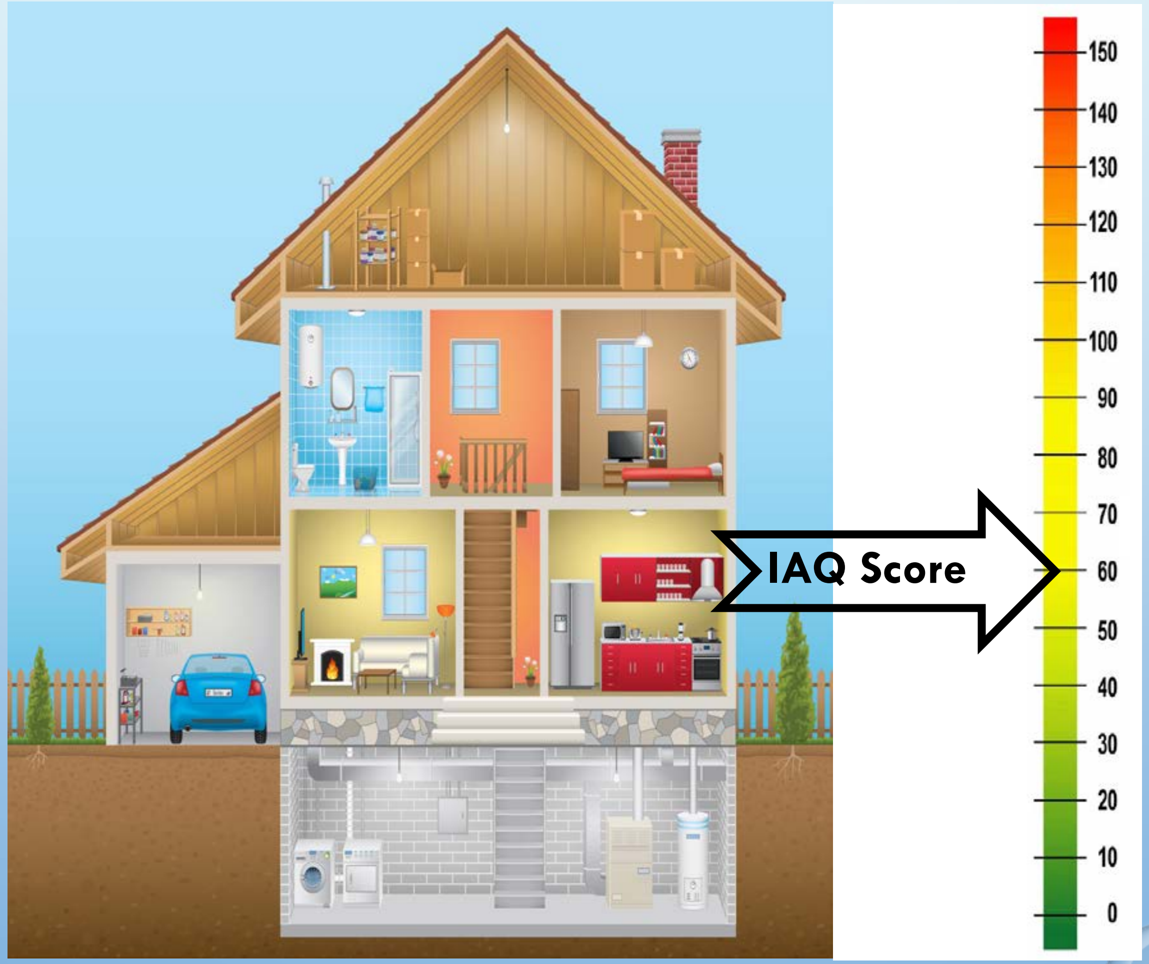
IAQ Metrics needs more research investment

- Need to know all contaminants of concern, emission rates, impacts, etc.
- Need to monetize acceptability & moisture like for DALYs. (e.g. via harm)

IAQ Score is doable now

- Substitutes expert judgement for quantitative metrics
- LBL has been developing…

IAQ SCORE DEVELOPMENT

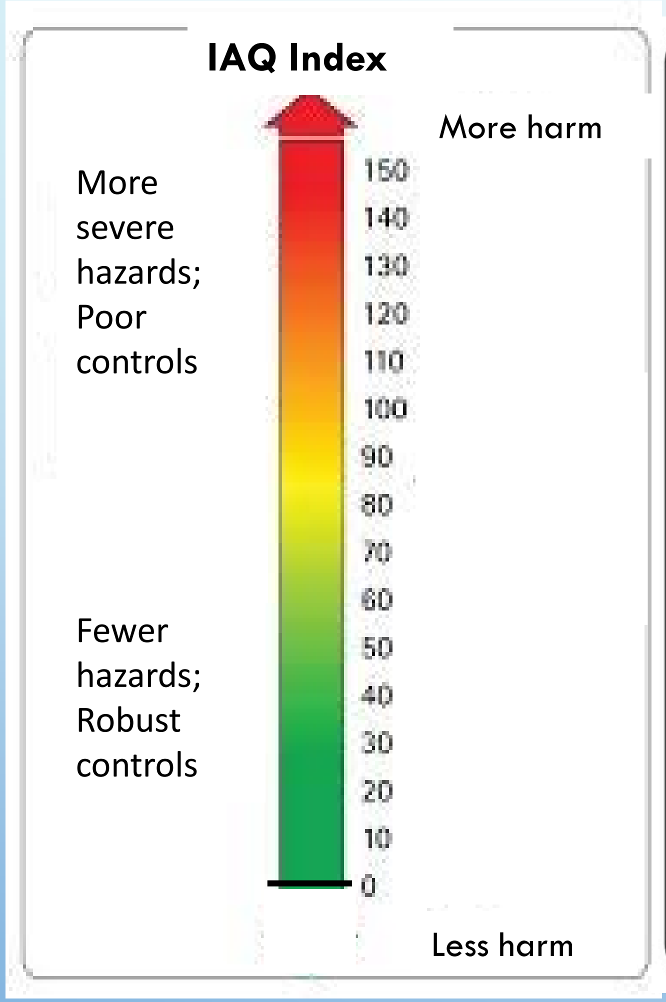


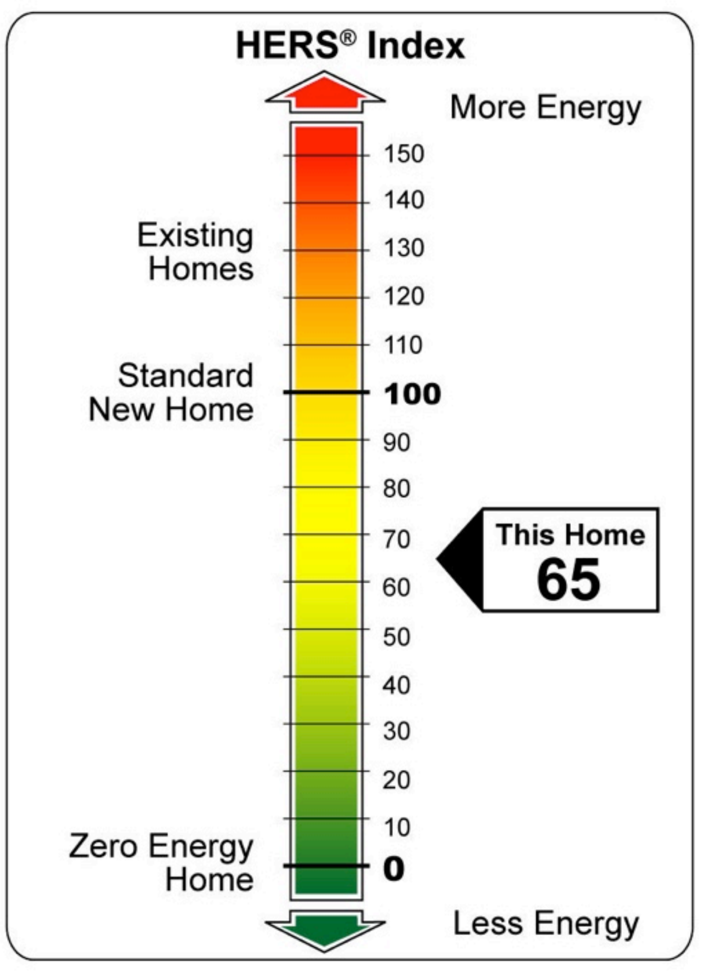
SCORE VISION IS SIMILAR TO METRICS VISION

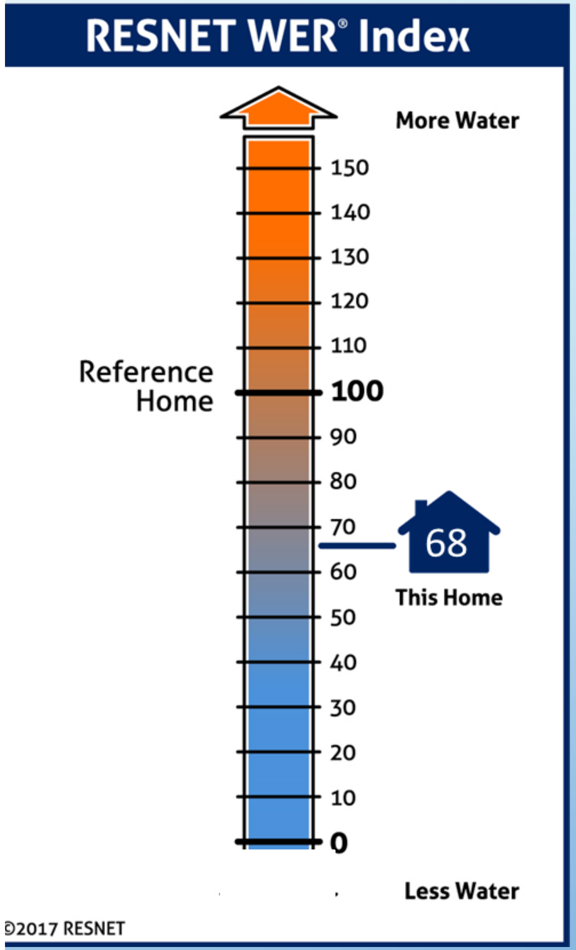
THE IAQ SCORE CAN BE USED TO ADDRESS IAQ CHALLENGES

Rate	homes and inform buyers and sellers.
Guide	new home designs and retrofits to improve IAQ
Improve	codes, standards, programs and regulations
Serve	as an interim IAQ Metric

MODELED AFTER HERS







IAQ Scoring Framework

Raters rate house as found

- Use typical occupant patterns

Identify hazards and potential harm

- Based on expert judgement

Evaluate hazards mitigation (control) impacts

- Based on expert judgement

No reference house

- Can be applied to new or existing

IMPORTANT FEATURES

No prescriptive requirements – this is a scoring tool

Measurements not required; but scores improve when device performance is verified

Many parameters have defaults; rater enters locally correct values

- Enables score when data not available
- Examples: Outdoor AQ, Radon, Fan flows….

Raters have to assess some hazards or controls

IAQ HEALTH RISKS

Contaminants identified by location and source

- Kitchen: Cooking emits $PM_{2.5}$, NO2, VOCs, etc.
- Outdoors: NO_2, PM2.5, ozone, etc.
- Building materials: formaldehyde, VOCs, SVOC
- Foundation: Moisture from ground

Contaminants

- CO, NO_2 & NO;
- PM: PM2.5, PM10, UFP
- VOCs: Formaldehyde, general VOC, SVOC, and other chemical hazards;
- Ozone; Radon;
- Mold; Allergens; Other biological hazards

Risks assessed for general population

- Hazard score considers toxicity and typical amount of exposure
- Risk for general population including susceptible groups

SPECIAL HAZARDS THAT INCREASE SCORE

- Unvented combustion appliance(s)
- Traditional fireplace
- Bad outdoor air quality, nearby sources
- Indoor hot tub or sauna
- Chemical contamination, e.g. from tobacco
- Visual or odor evidence of dampness & mold

NOT INCLUDED IN SCORE – OCCUPANT SPECIFIC

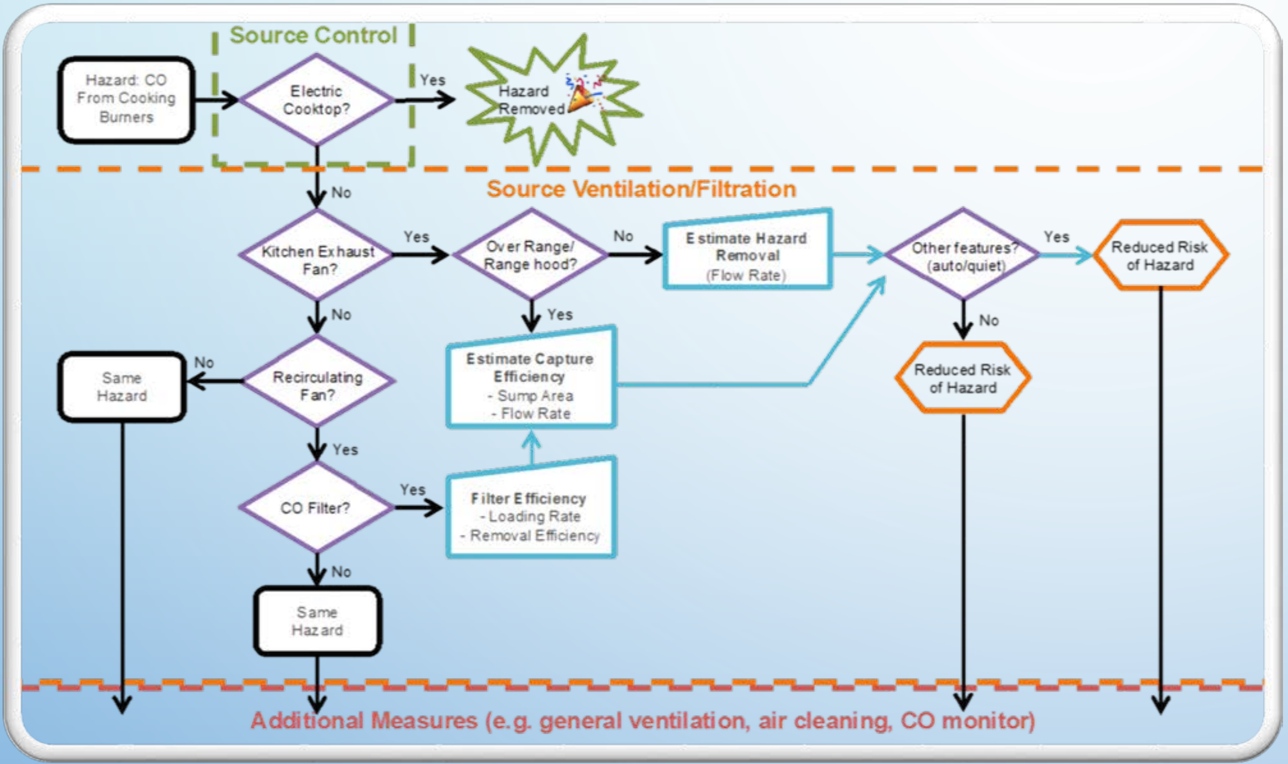
- Current smoking
- Pollutants from unusual hobbies, extreme activities
- Chemicals presently in home
- Number of current residents
- Current pets
- Clutter, dirt, grime, dirty laundry, etc.

CONTROLS ARE BUILDING ASSETS THAT MITIGATE HARM

Effectiveness of some controls will vary with home characteristics

Default values may be needed for some controls

- Range hood capture efficiency
- Range hood air flow rate
- Bathroom fan air flow rate
- Whole house ventilation



SCORING APPROACH EXAMPLE: CO FROM COOKTOP BURNER

EXAMPLE: CALCULATING A PIECE OF AN IAQ SCORE

Source of Hazard:

- Gas Range (oven under cooktop)
  - Two pilot burners

Existing Controls:

- Range hood
  - 150 cfm measured
  - 2 sones HVI-rated (or ~40 dB)
  - Unknown capture efficiency (CE)
  - Max flow of 300 cfm
- General kitchen exhaust pulling 20 cfm from kitchen

Health Hazards:
Gas Cooktop, two pilot burners

IAQ Score Type	HEALTH										
Pollutant	PM2.5	PM2.5	PM2.5	PM2.5	NO2	NO2	NO2	NO2	VOC	VOC	VOC
Source Category	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Indoor sources
Source	Gas cooktop	Gas oven under cooktop	Gas oven not under cooktop	Pilot burner(s)	Gas cooktop	Gas oven under cooktop	Gas oven not under cooktop	Pilot burner(s)	Cooking under range hood	Cooking not under hood, general food prep	Furnishings, Hobbies, Personal care prods
Contaminant Score -->	10	7	7	2	7	7	7	5	2	1	3
Hazard Quantity	1	1	0	2	1	1	0	2	1	1	1
Health Hazard	10	7	0	4	7	7	0	10	2	1	3

Source Contaminant Score ★ Quantity of Hazards = Health Hazard

IAQ Score = Sum of Reduced Hazard Scores

Control	Control Detailed Description	Control Scoring criteria	IAQ Score Type: HEALTH										
			Pollutant	PM2.5	PM2.5	PM2.5	PM2.5	NO2	NO2	NO2	NO2	VOC	VOC	VOC
			Source Category	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Kitchen	Indoor sources
			Source	Gas cooktop	Gas oven under cooktop	Gas oven not under cooktop	Pilot burner(s)	Gas cooktop	Gas oven under cooktop	Gas oven not under cooktop	Pilot burner(s)	Cooking under range hood	Cooking not under hood, general food prep	Furnishings, Hobbies, Personal care prods
			Contaminant Score -->	10	7	7	2	7	7	7	5	2	1	3
			Hazard Quantity	1	1	0	2	1	1	0	2	1	1	1
			Health Hazard	10	7	0	4	7	7	0	10	2	1	3
				Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier	Control Multiplier
General Kitchen Exhaust														
20 cfm	Any continuous kitchen exhaust	10%		0.1	0.1		0.1	0.1	0.1		0.1	0.1	0.1	0.1
	Measured air flow rate	+/-5% every 5 cfm above/below 20												
	Rated air flow rate	+/-3% every 5 cfm above/below 20 cfm												
	Location, better if directly above cooking device, scored separately for cooktop and oven if separate appliances	5%												
Range hood exhaust														
	Any exhaust range hood (default)	40%		0.4	0.4			0.4	0.4			0.4		
	Rated CE and flow measured	%CE												
	Rated CE	%CE*0.8												
150 cfm	Measured air flow rate	+/-5% every 50 cfm above/below 100 cfm		0.05	0.05			0.05	0.05			0.05		
	Rated air flow rate	+/-3% every 50 cfm above/below 100 cfm												
	Measured sound @ CE or flow rate	+/-10% every 1 sone above/below 3 sones												
2 Sones	Rated sound @ CE or flow rate	+/-7% every 1 sone above/below 3 sones		0.07	0.07			0.07	0.07			0.07		
300 cfm	Airflow at highest setting (to deal with emergencies)	+ 10% every 50 cfm above 200 up to 400 cfm		0.2	0.2			0.2	0.2			0.2		
	Auto operation, e.g. linked to humidistat, pollutant mst or interlocked with range	10%												
Reduced Hazard Score				1.8	1.26		3.6	1.26	1.26		9	0.36	0.9	2.7

IAQ Score (Summed) 22.14

NEXT STEPS

For IAQ Score

- LBL hopes to have beta test this year
  - Browser based
- Create version for general use next year

For IAQ Metrics

- Needs more research on key aspects
  - Health researchers, economists, etc
- LBL efforts on hold

CONCLUSION

IAQ Metrics enable use of powerful optimization and economic tools to improve buildings

- Years away from full achievement
- Ventilation metrics help pave the way

IAQ Score gives similar functionality in the interim

- Hopefully available for use within a year

THANK YOU

QUESTIONS?

University of Nottingham
UK | CHINA | MALAYSIA

SESSION 2: VENTILATION FOR INDOOR AIR QUALITY AND HEALTH

Heat stress resistance in the Nationwide House Energy Rating Scheme

Project team

Dr Gertrud Hatvani-Kovacs
Dr Martin Belusko
Dr John Pockett
Professor John Boland

19 March 2018

Heatwaves in Australia

- Heatwaves are the most deadly natural hazard
- The frequency and intensity of heatwaves are rising due to climate change
- Heatwaves are exacerbated by Urban Heat Islands with 89% of Australians living in cities and towns
- Ageing population

Solution: air conditioning

"According to the Australian animal welfare standards and guidelines for exhibited animals, all animal enclosures must provide temperature and humidity control," she said. "So why does the Australian government care enough about the well-being, comfort and care of zoo animals to create legislation in the interests of animal protection, yet does not show the same level of compassion and devotion to our elderly citizens?

G4
G5
G6
G7

Shockingly, half of all public classrooms in Western Sydney have no air-conditioning at all, but we've had three 40 degree days in the last three weeks alone. Can you imagine trying to learn in that environment?

There is a renewed push for air-conditioning to be installed in social housing sites in regional New South Wales, where temperatures exceed 40 degrees Celsius several days per year.

Slide 3

G4 All of these are from public petitions
Gertrud, 19/03/2018

G5 http://www.abc.net.au/news/2016-03-30/calls-for-nsw-government-to-take-air-conditioning-seriously/7284494
Gertrud, 19/03/2018

G6 http://www.dailytelegraph.com.au/rendezview/all-school-classrooms-should-have-airconditioning/news-story/bc4cb132c58034f9a9df3cf9ecd68
Gertrud, 19/03/2018

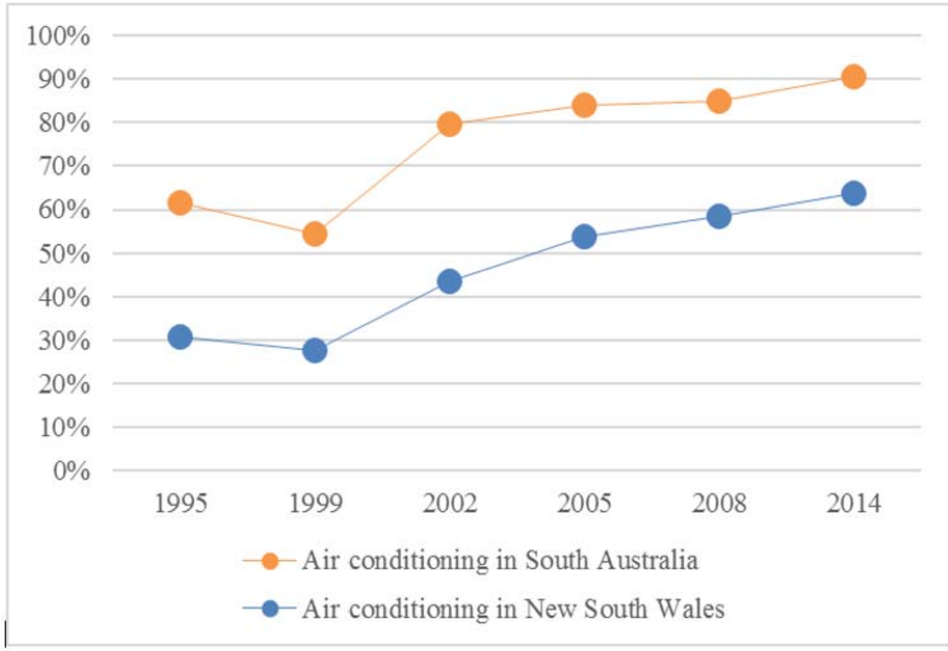
G7 https://www.thesenior.com.au/news/petition-gathers-momentum/
Gertrud, 19/03/2018

Solution: air conditioning

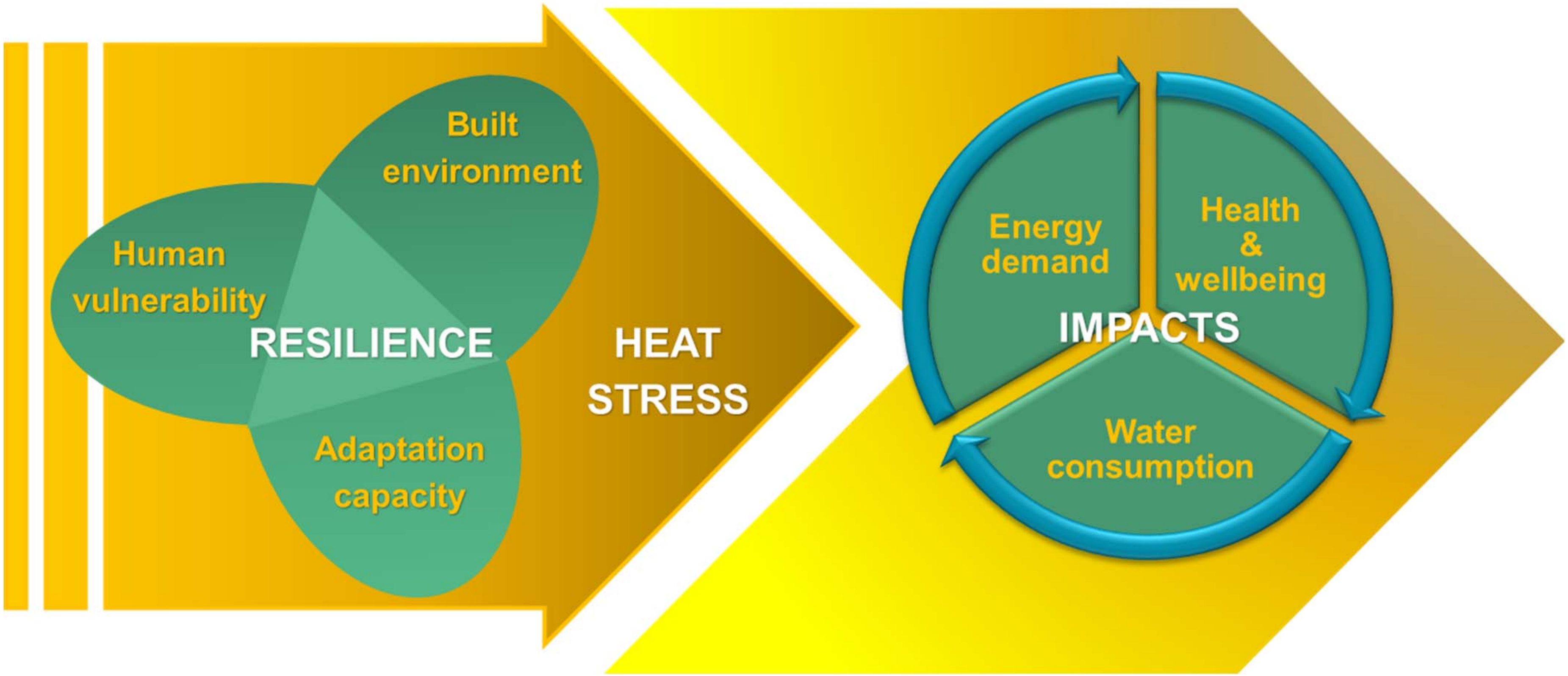
- drives peak electricity demand, prices and energy poverty

- warms up the outdoors

- increased dependence



What can we do?



Are our buildings heat stress resistant?

Online survey

- Representative sample from Adelaide (N=393)
- Panel provider

- Questions about
  - Demography
  - Built environment
  - Retrofitting activity
  - Adaptation
  - Heat-related health problems

NatHERS

- Two compliance pathways: elemental approach and simulation compliance

- Rates dwellings from 1 to 10 stars

- Minimum requirement is 6 stars

- NatHERS software

- Based on the annual thermal energy requirement, including both heating and cooling

AccuRate simulation

AccuRate building energy simulation of design variations with a typical floor plan

Traditional double-brick and brick veneer from the 70s

New homes from 6 to 8 stars

Floor plan and section of the simulated home

House design elements

Star rating in Adelaide	2.6 stars (double brick)	2.6 stars (brick veneer)	6.2 stars cooling-dominant	6.2 stars heating-dominant	7.1 stars heating-dominant	7.2 stars cooling-dominant	8.0 stars cooling-dominant	8.0 stars heating-dominant
Star rating in Sydney	2.3 stars (double brick)	2.4 stars (brick veneer)	5.6 stars cooling-dominant	5.7 stars heating-dominant	6.7 stars heating-dominant	6.9 stars cooling-dominant	7.9 stars cooling-dominant	8.1 stars heating-dominant
Roof colour, material and total solar absorptance	light metal (0.30)	light metal (0.30)	dark tiles (0.75)	white, concrete tiles (0.25)	white, concrete tiles (0.25)	dark metal (0.75)	dark metal (0.75)	white, concrete tiles (0.25)
Foil in roof	NIL	NIL	NIL	yes	yes	NIL	NIL	yes
Roof insulation	NIL	NIL	NIL	NIL	NIL	NIL	R2	R2
Ceiling insulation	NIL	NIL	R4.0	R4.0	R4.0	R4.0	R4.0	R4.0
External wall	double brick with cavity	brick veneer	brick veneer, R2.5	brick veneer, R2.5	brick veneer, R2.5	brick veneer, R2.5	brick veneer, R3.5	reverse brick veneer, R3.5
Foil in wall	NIL	NIL	NIL	NIL	NIL	NIL	yes	yes
Internal walls	brick	plasterboard	plasterboard, R1.5	brick	brick	plasterboard, R1.5	plasterboard, R2.0	plasterboard, R2.0
Windows	single, clear glazing	single, clear glazing	single, high solar gain (U=5.4 W/m^{2}K)	single, low solar gain (U=5.6 W/m^{2}K)	double, low solar gain (U=3.0 W/m^{2}K),	double, argon, high solar gain (U=2.90 W/m^{2}K)	double, high solar gain (U=2.0 W/m^{2}K),	double, low solar gain (U=2.0 W/m^{2}K),
Roller shutters	in western bedrooms	NIL	NIL	in western bedrooms	in western bedrooms	NIL	NIL	all rooms
Floor slab	suspended timber floor	slab-on-ground	slab-on-ground	slab-on-ground	slab-on-ground	225 mm waffle pod	225 mm waffle pod	slab-on-ground
Floor covering	timber	ceramic & carpet	ceramic & carpet	ceramic & carpet	ceramic & carpet	ceramic & carpet	ceramic & carpet	ceramic only
Fan	NIL	NIL	NIL	NIL	NIL	NIL	NIL	in main rooms

Results of the online survey

- The health of one fifth of the population was affected by heatwaves
- Three quarters of dwellings were reported as having insufficient heat stress resistance
- Roof and wall insulation, and double glazing predicted less health issues
- Availability and level of air-conditioning correlate with less natural adaptation

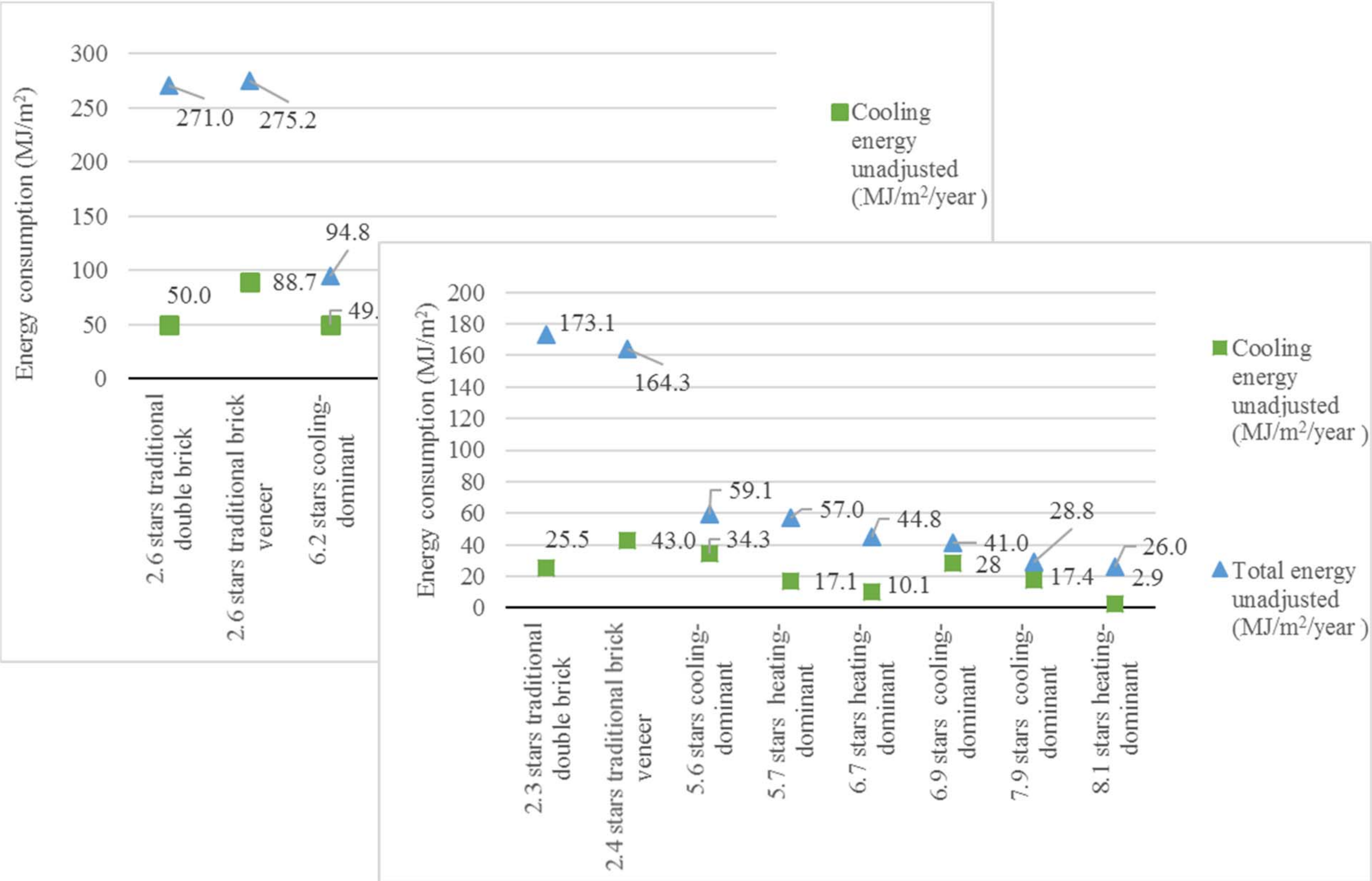
G1
G2

Slide 12

G1 Availability- yes or no
Gertrud, 19/03/2018

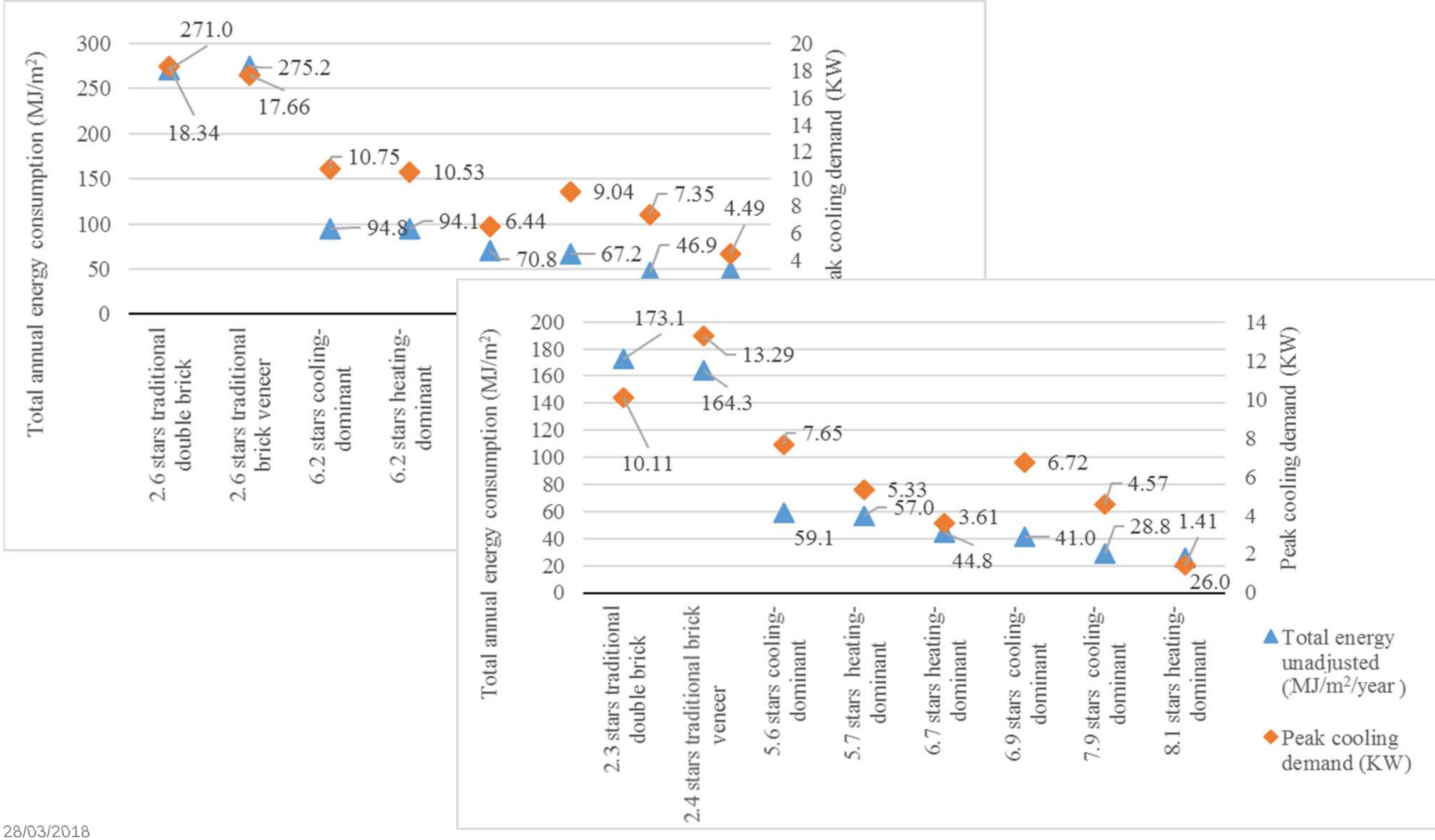
G2 Level: one-room, two-rooms or more, whole house
Gertrud, 19/03/2018

Cooling energy and star rating in Adelaide and Sydney



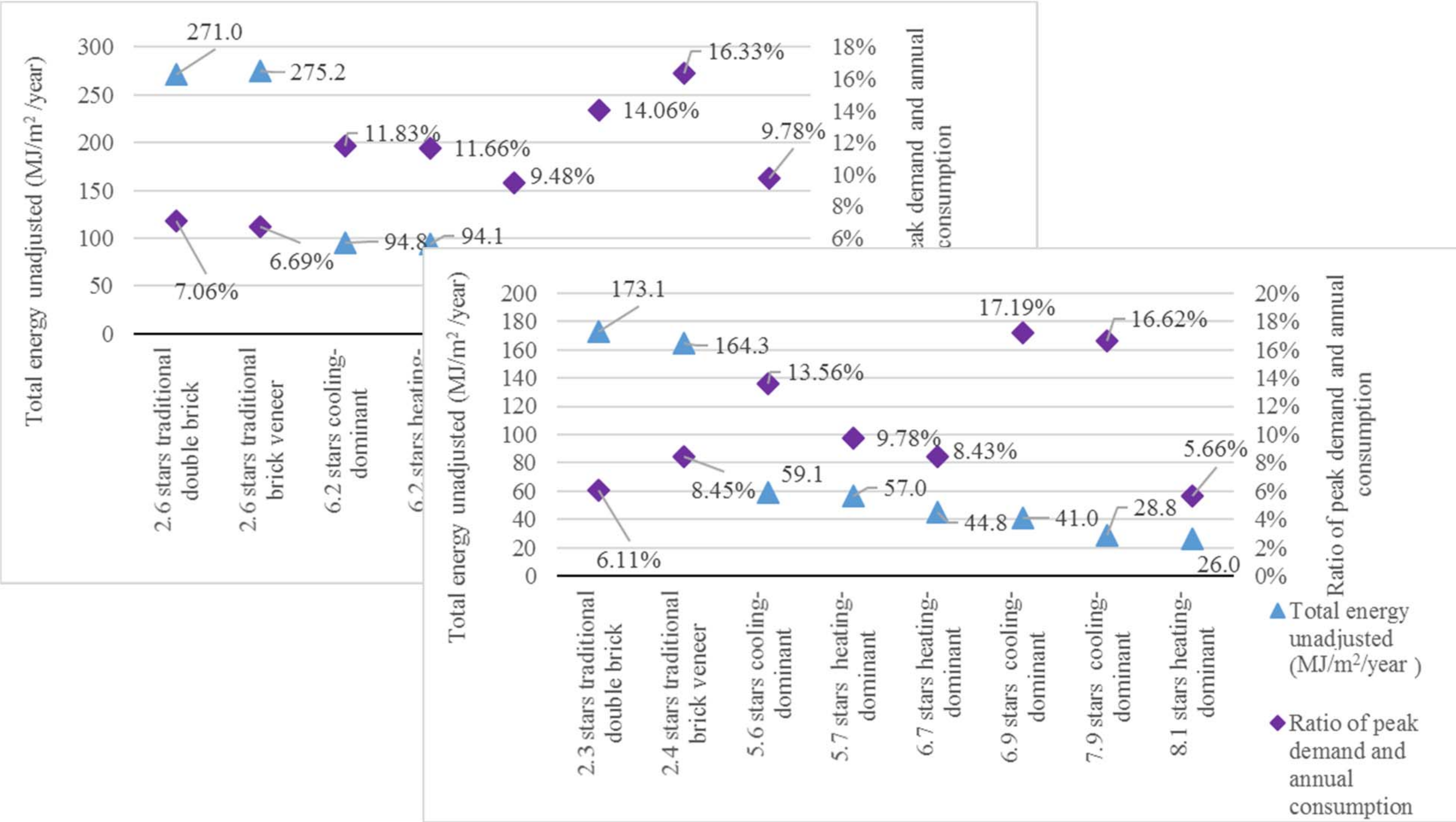
LOW CARBON LIVING CRC

Peak cooling demand and star rating in Adelaide and Sydney



LOW CARBON LIVING CRC

Relative peak cooling demand and star rating in Adelaide and Sydney

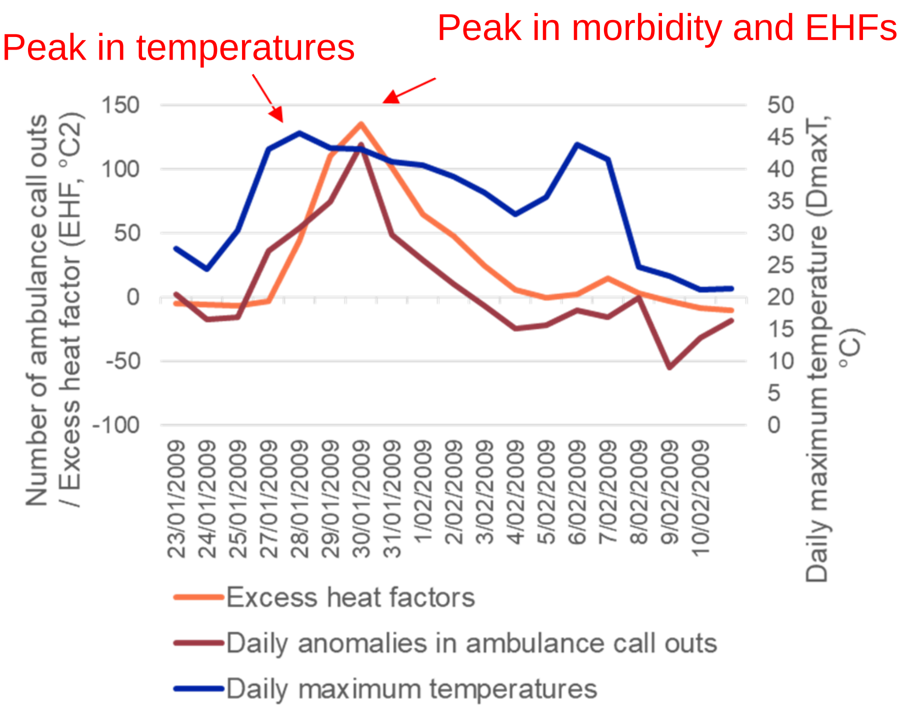


Overheating thresholds

- Static threshold adopted from AccuRate thermostat set point for cooling

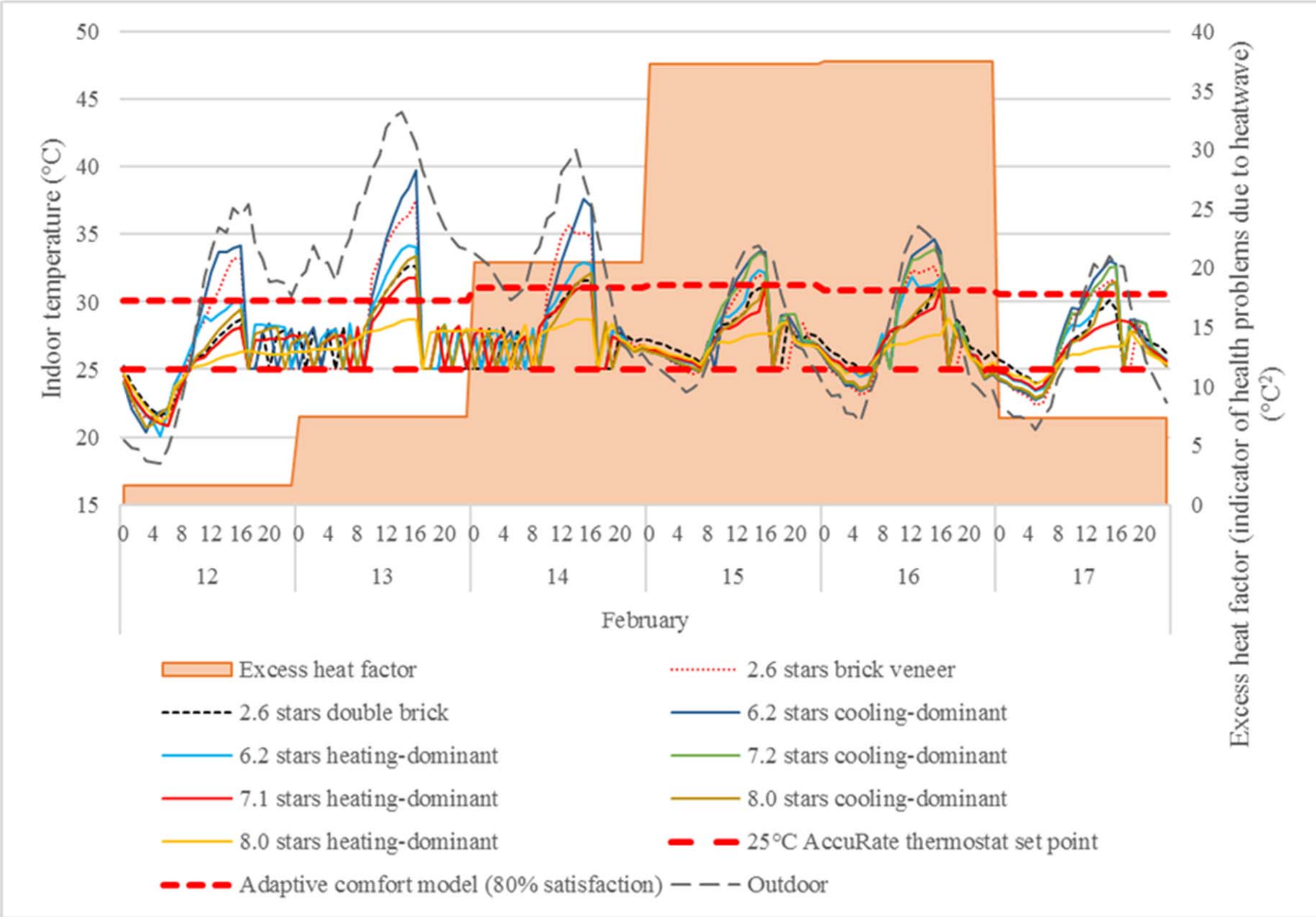
- Upper limit of the adaptive comfort model (Morgan and de Dear, 2003)

- Excess heat factor (Nairn and Fawcett, 2015)



LOW CARBON LIVING CRC

Overheating analysis in Adelaide

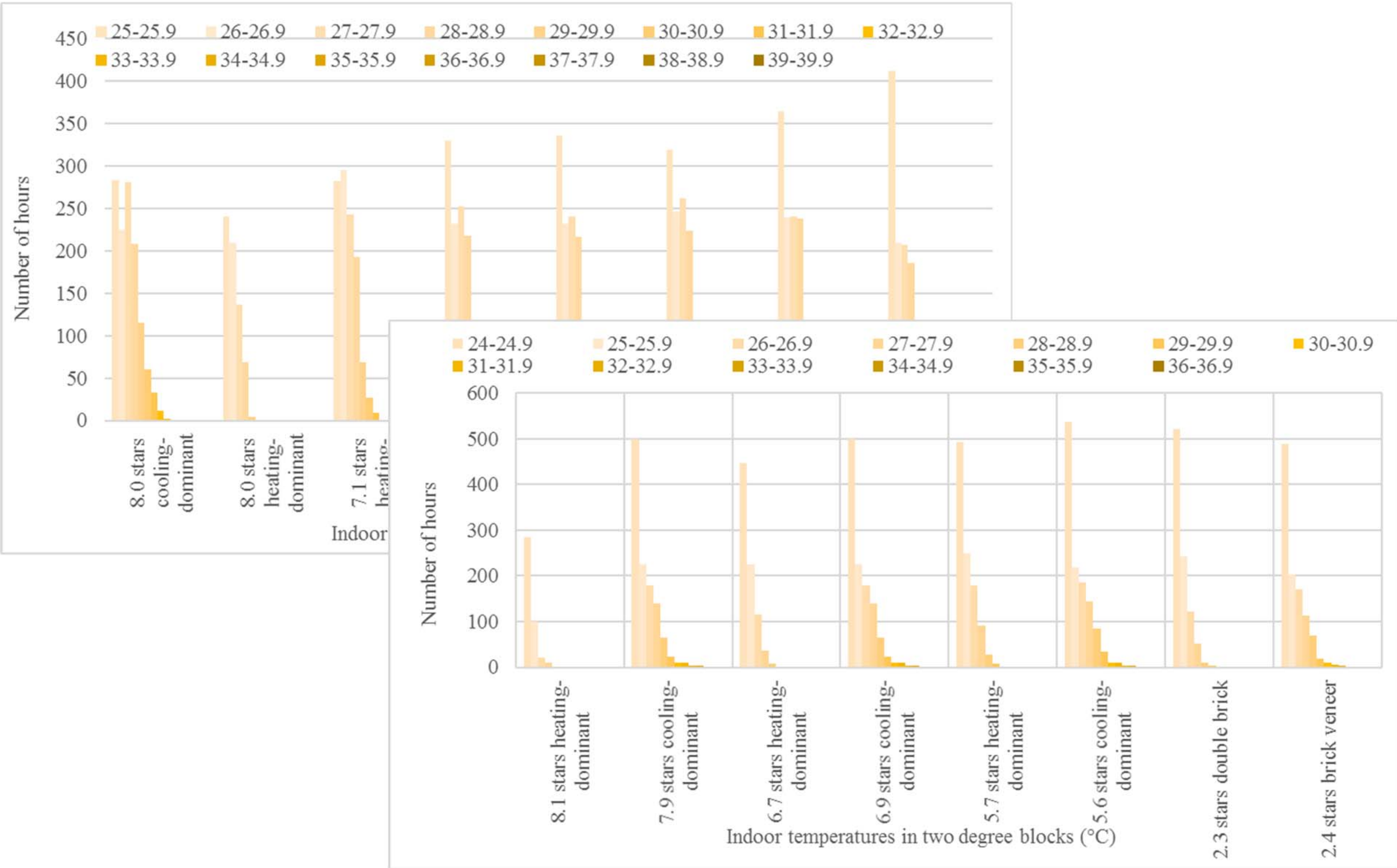


G9 North-facing bedroom

Gertrud, 21/03/2018

G3

Overheating analysis in Adelaide and Sydney



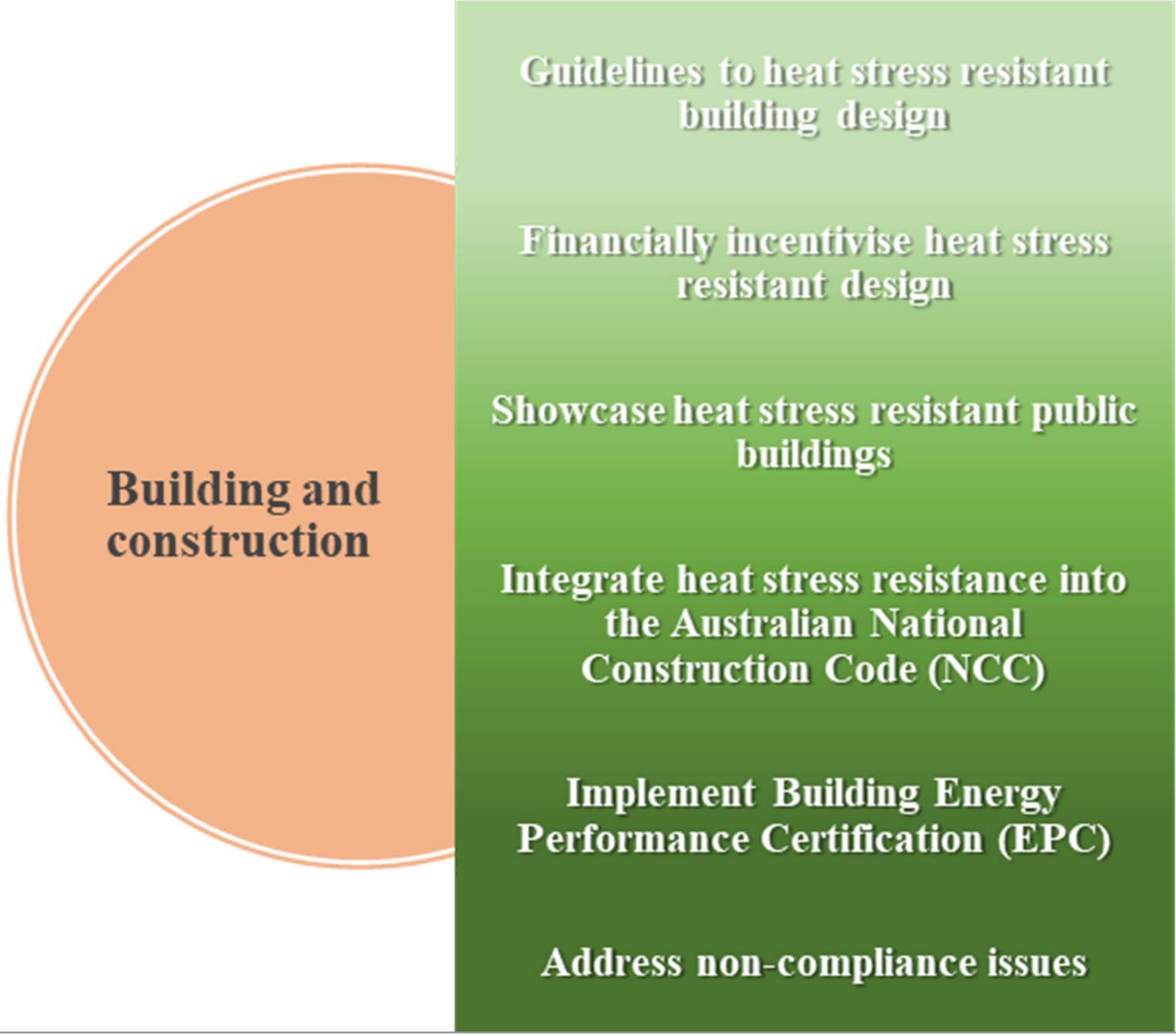
Slide 18

G3 in the bedroom

Gertrud, 19/03/2018

G8

Policy recommendations



G8 Financial incentive: lower tax for white coloured roof materials

Gertrud, 19/03/2018

Review NatHERS and BASIX

NatHERS

Report separately both heating and cooling (version 2019)

Set separate thresholds for heating and cooling

Run simulation in free-running mode with overheating thresholds

Implement future TMY

Thank you

To find out more, contact

gertrud.hatvani-kovacs@mymail.unisa.edu.au

CRC for Low Carbon Living Ltd

Room 202-207, Level 2,
Tyree Energy Technologies Building
UNSW Sydney NSW 2052 Australia

E: info@lowcarbonlivingcrc.com.au
P: +61 2 9385 5402
F: +61 2 9385 5530

Twitter: @GertrudHatvani
@CRC_LCL

Ventilation Workshop - Sydney

Exposure due to cooking

Willem de Gids

Wouter Borsboom

Piet Jacobs



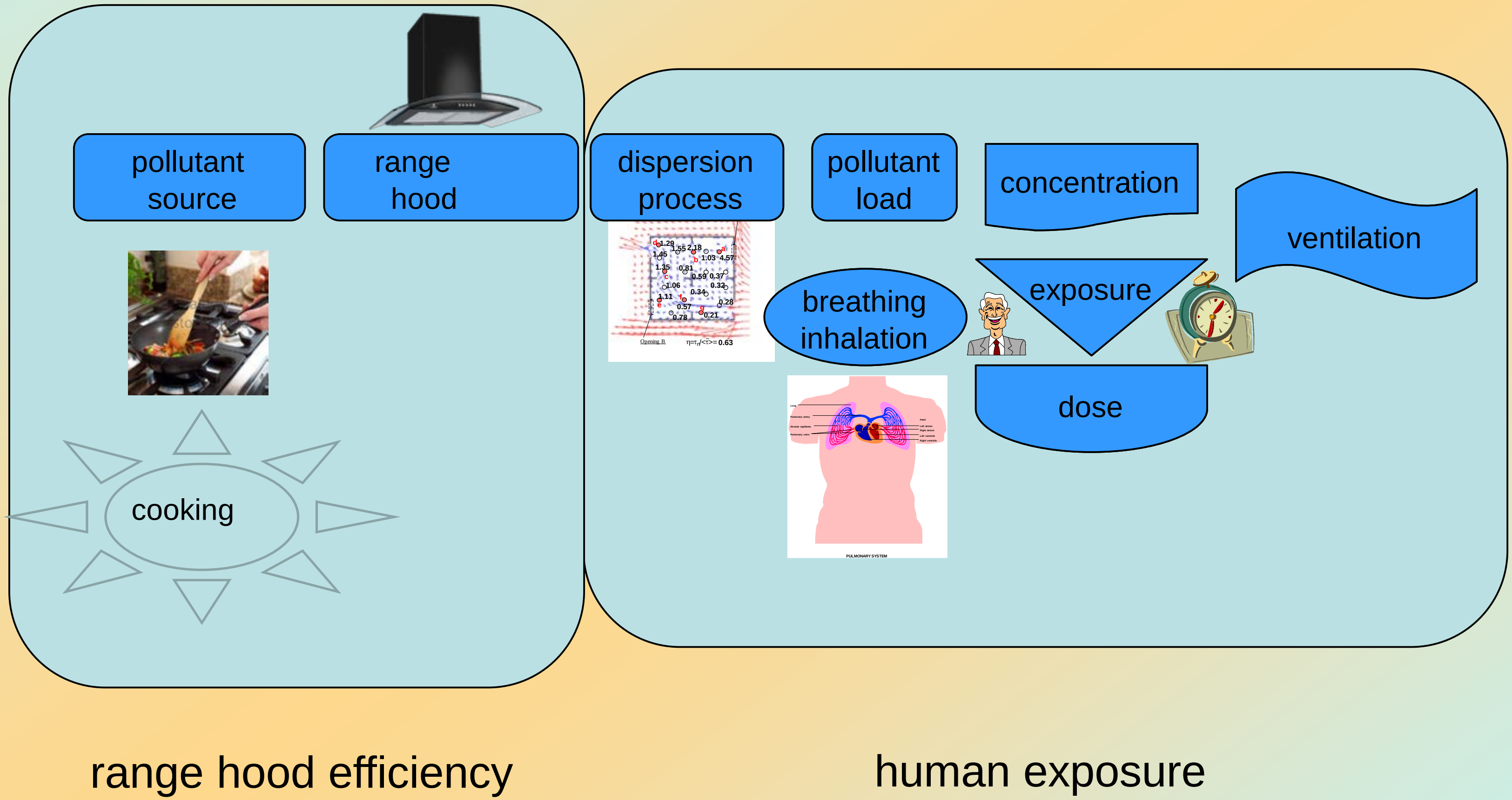
Range hood efficiency ?

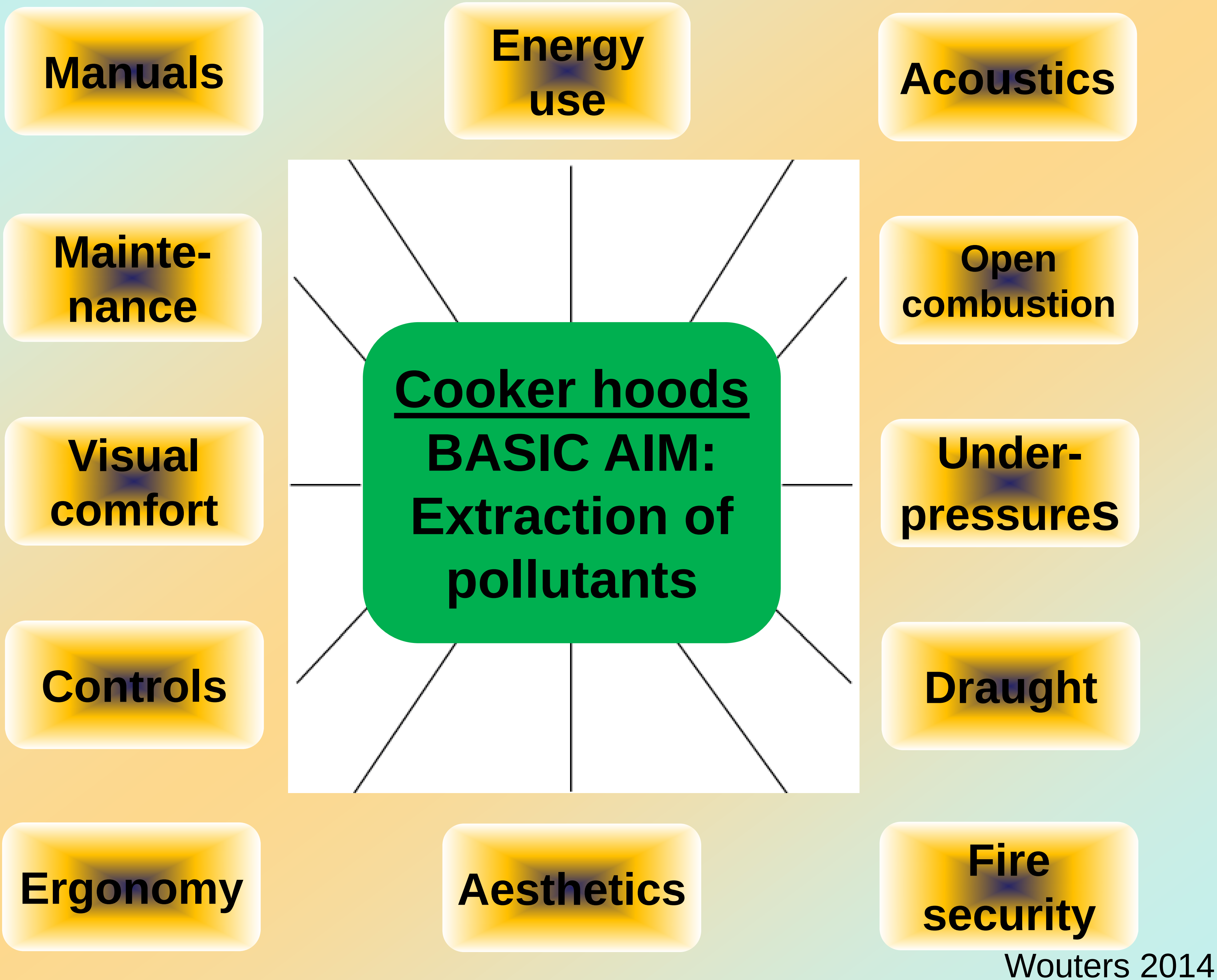
It is exposure that matters !

Considerations

- For comparing range hoods as a product measuring capture efficiency satisfies
- For people finally the exposure to pollutants from cooking is more relevant
- The exposure of people
  - the hood efficiency but also the way people behave in front of the rangehood plays an important role

Pollutant process during cooking




Manuals
Energy use
Acoustics
Mainte-nance
Open combustion
Cooker hoods
BASIC AIM: Extraction of pollutants
Visual comfort
Under-pressures
Controls
Draught
Ergonomy
Aesthetics
Fire security
Wouters 2014

Influencing factors on the hood efficiency

- Hooddesign
- Flowrate(s)
- Height above hob
- Adjacent cupboards
- Source strength
- Position of source
- Type of the souce
- Gas/ceramic/induction

There are several standards for measuring the efficiency;

- ASTM
- Draft CEN
- Swedish standard SS-EN 61591 A 11 includes interference

Several measurement methods

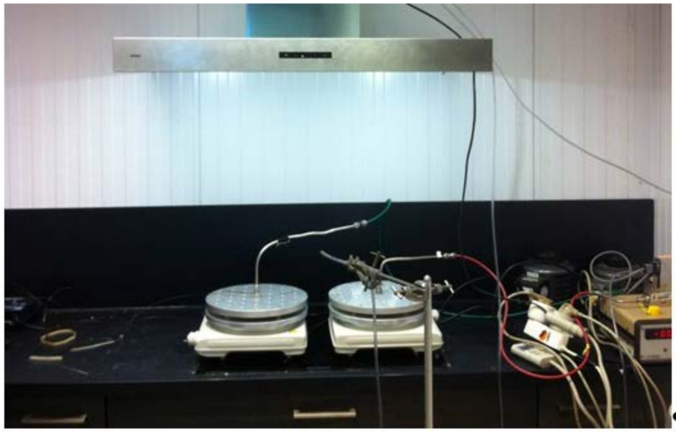


Figure 3. ASTM (2017) emitters on two electric heating (600 W) electric hot plates

Reproducibility is a problem

Figure 2. Induction method with CO_2 injection in two stainless steel 24 cm stir-fry-pans in the front locations, the left pan is equipped with temperature sensors.

Efficiency including interference

Air flow [m³/h]	With interference device	Without interference device
450	0.74	0.97
300	0.66, 0.67	0.89, 0.90
200	0.46, 0.49	0.95, 0.96

ratio in %

76

74

50

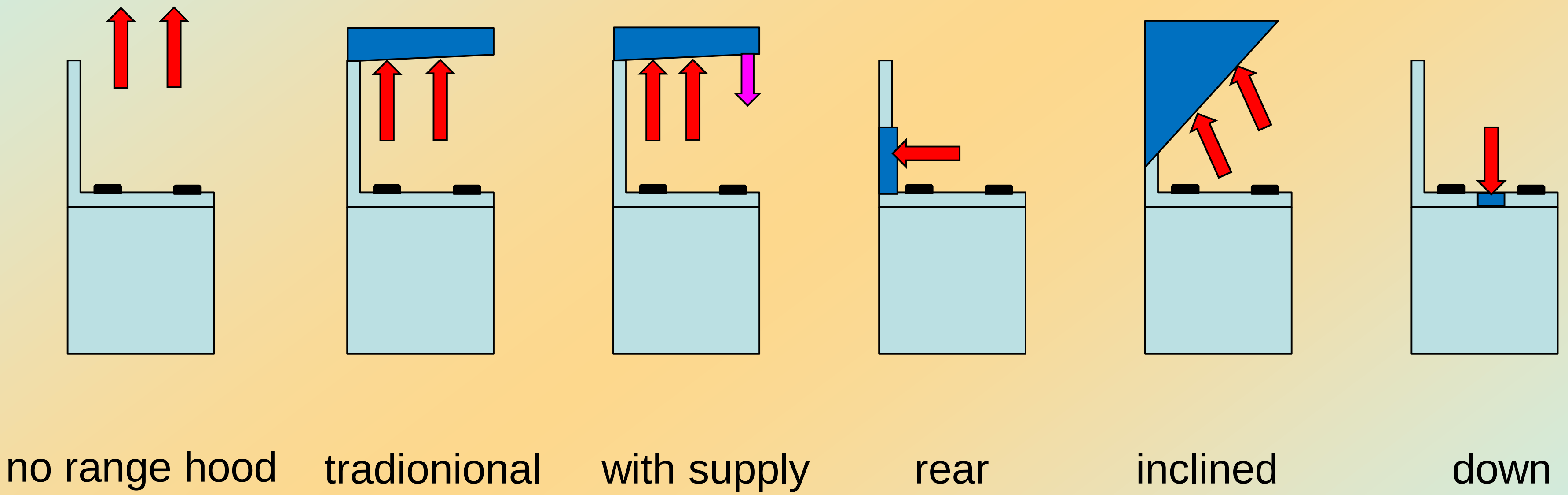
CETIAT J. Simon 1984

no range hood

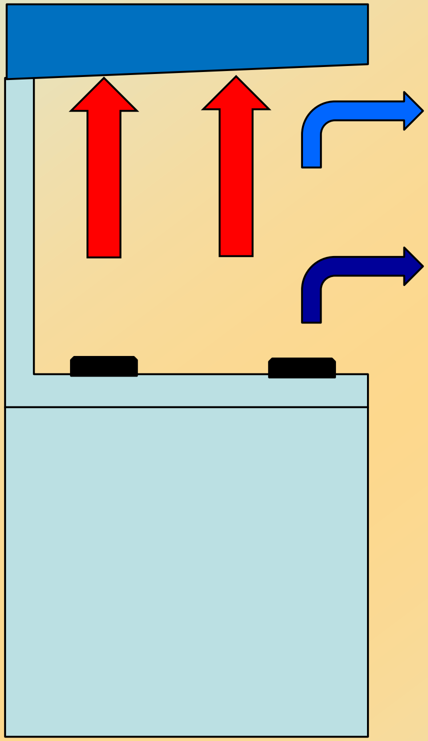
traditional range hood

recent development

Type of cooking exhaust



Interference/disturbance due to cooking increasing the exposure



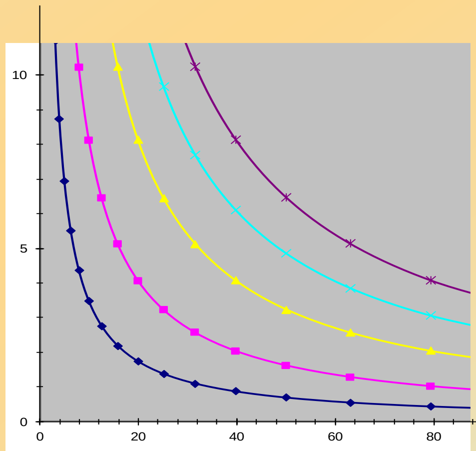
- inefficient exhaust
- smelling
- body movements
- arm movements

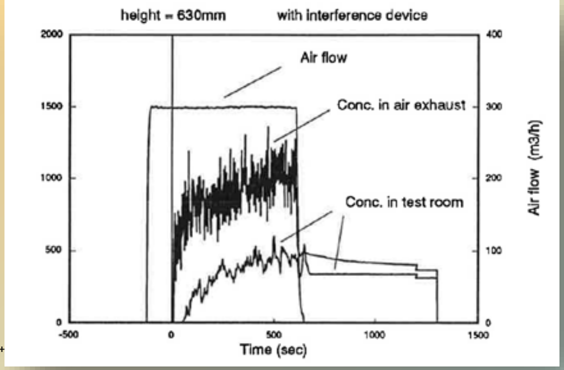
Interference or disturbance effect is depending on exhaust type

Role of ventilation in kitchen/living

Kitchen/living normally almost perfect mixed air
But in the vicinity of the hob is it not the average concentration

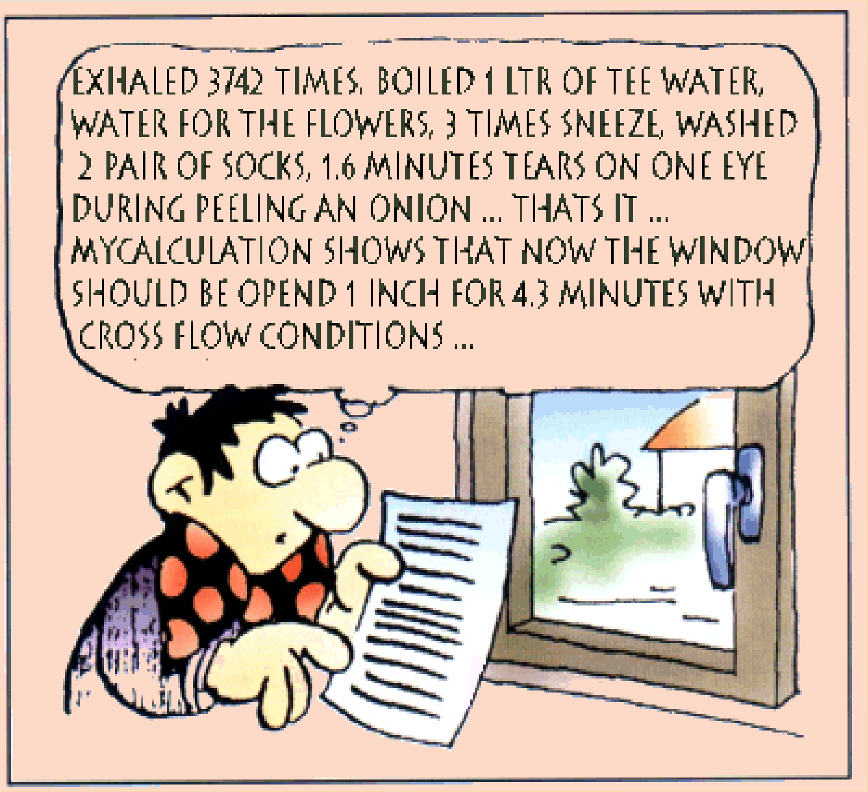
Exposure during
- Cooking
- Period after

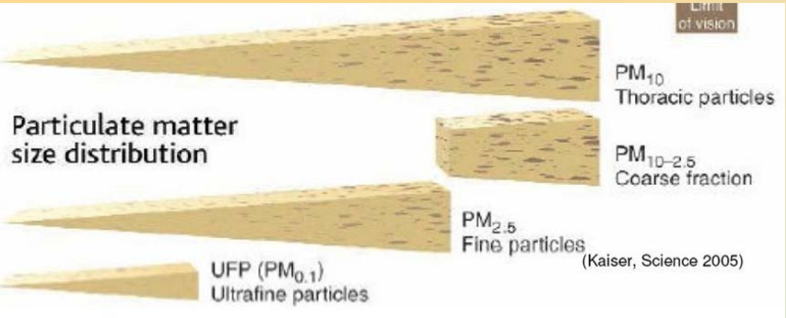




The exposure is the integration over time
of the concentration during cooking and after cooking

What do users know about ventilation and exposure?





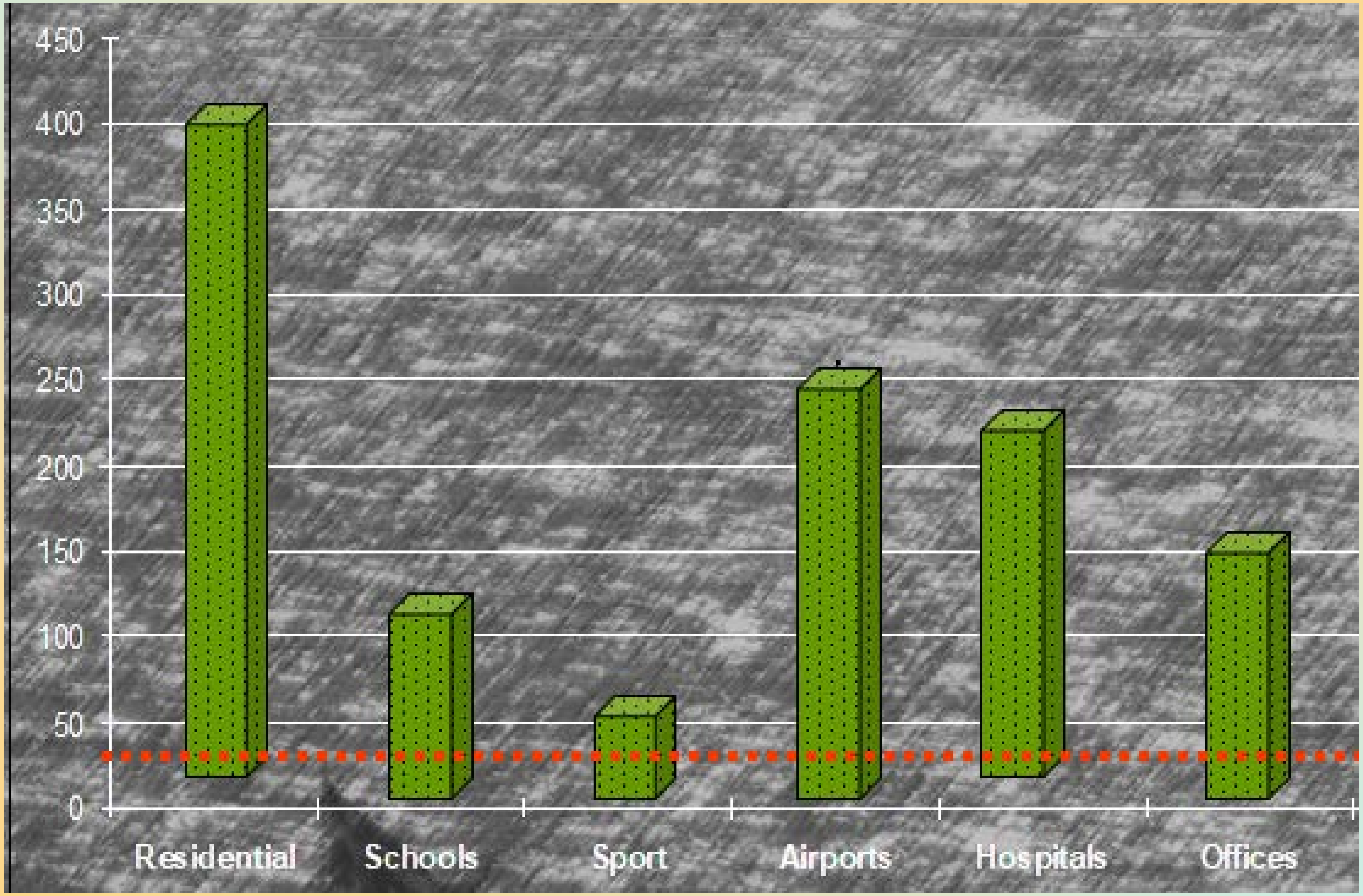
The only thing they really no is:

switch off the range hood because of the noise

The exposure to fine dust during cooking

- TNO has carried out long term exposure study on persons due to cooking
- The focus was on particle fine dust PM2.5
- Three different exhaust strategies
  - No range hood
  - Standard range hood
  - Inclined Range hood
- Two different extract rates
  - low
  - high

Concentration of PM2.5 types of Buildings

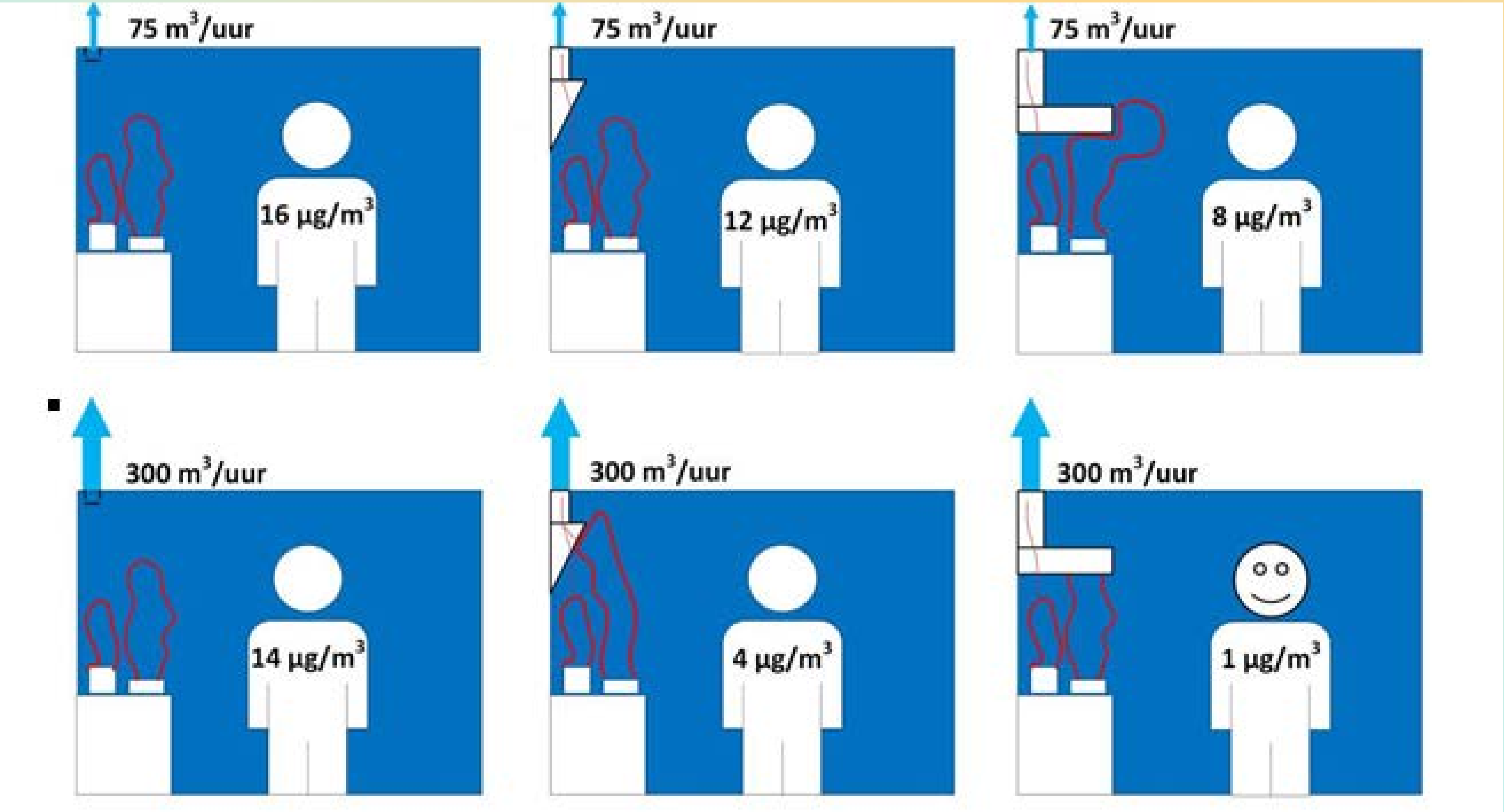


Santamouris 2013

The exposure study

- Cooking a full Dutch meal for 2,2 persons causes an emission of 35 mg $PM_{2,5}$
- Dutch people: a meal is cooked on average 5 times a week
- The average daily emission is 25 mg $PM_{2,5}$
- An open kitchen/living with a volume of 96 m^3
- Cooking 10 minute emission constant emission rate of 41,6 µg/s
- Dilution flow of 28 dm^3/s for the kitchen/living

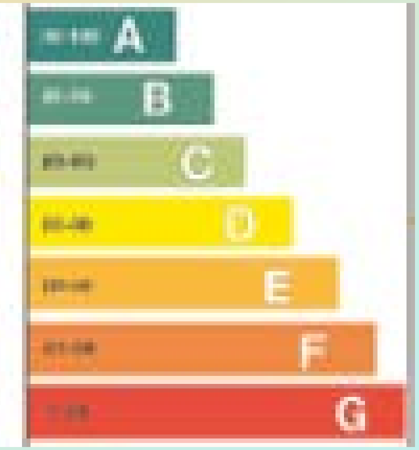
Results of exposure study



How to come from efficiency to exposure

Several possibilities :

- Adding a correction approach in the existing efficiency measurement standards on range hoods ?
- Composing a new standard ?
  - with a procedure to derive exposure from efficiency measurements
- Defining a kind of labelling systems for users to compare the different systems



Closing Remarks

- Hood efficiency measurements exists in several but very different standards
- TNO study showes that exposure is very important
- The challenge is now:
  - how to reach valuable information for users
  - Will it be in Standards or a labelling system
- A proposal for a CEN standard is in the preparation phase

- This presentation was to stimulate the audiance to consider exposure in stead of only hood efficiency

Thank you for
your attention

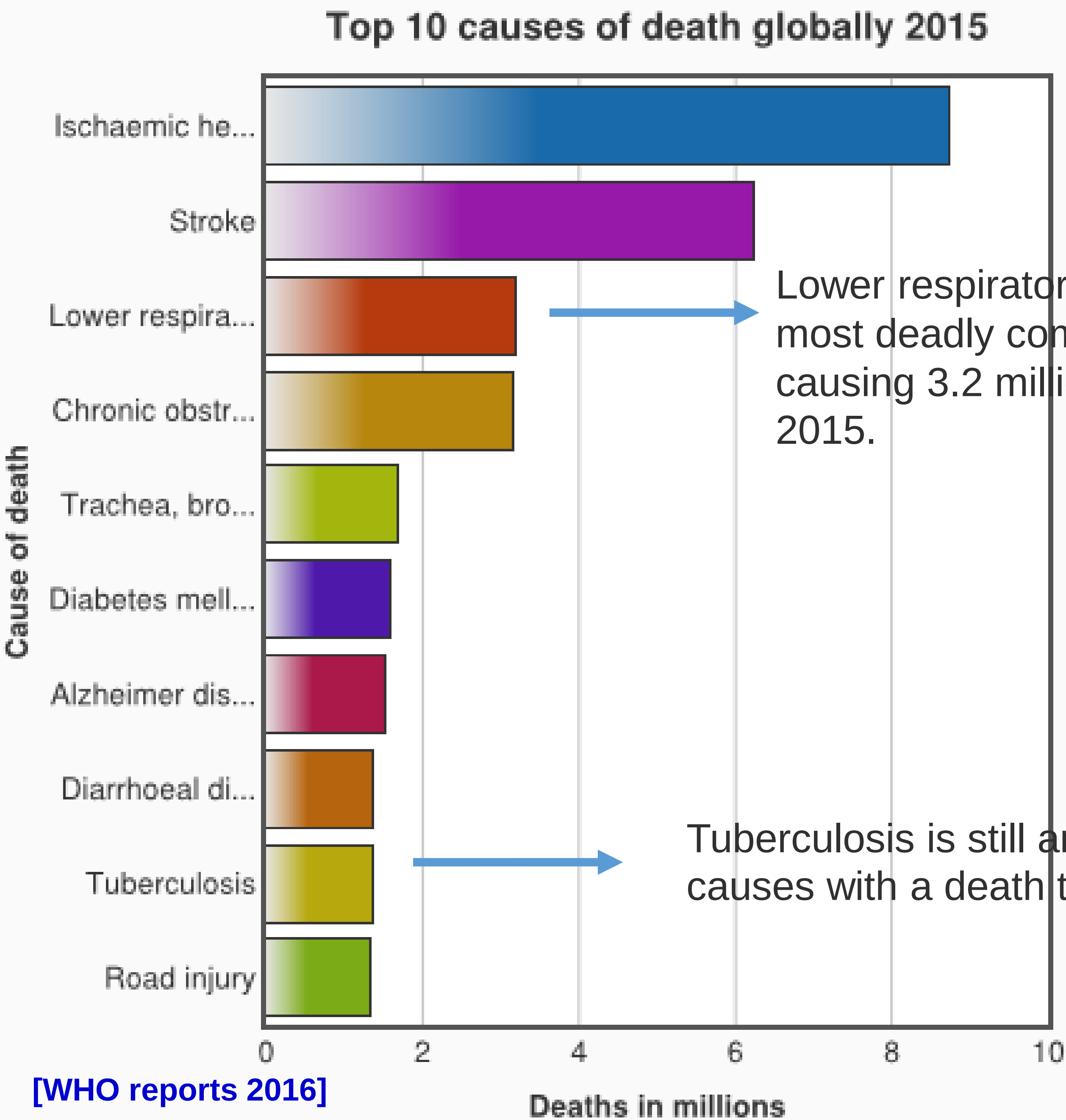
Ventilation and airborne infection control

Jianlei Niu,
Professor of Building, Environment and Energy,
Co-editor-in-chief of Energy and Buildings
E-Mail: jianlei.niu@sydney.edu.au

The University of Sydney School of Architecture, Design and Planning

Assessment of Risks and Control of Airborne Transmission of Infectious Diseases in High-rise Residential Environments

- Is there a significant risk of airborne infection, staying in one’s own home?
- What can we do, in terms of intervention, ventilation design or occupant behaviour?



Lower respiratory infections remained the most deadly communicable disease, causing 3.2 million deaths worldwide in 2015.

Tuberculosis is still among the top 10 causes with a death toll of 1.4 million.

[WHO reports 2016]

Common Cold and Influenza prevalence in urban population

NEWS ▸ NATIONAL ▸ NSW

NSW sees the worst flu season on record

Updated: 7:15 pm, Sunday, 6 August 2017

NSW has seen the worst flu season on record - with four separate strains of the virus affecting babies and young children the most.

More than 8200 people sought treatment for respiratory illness at emergency departments last week alone.

Of these, more than two thousand people were admitted to hospital, had life-threatening conditions or arrived by ambulance.

Influenza outbreaks shut down two more scho

Nickkita Lau

Influenza outbreaks affecting 91 students and staff have forced two more primary schools to close.

Ying Wah Primary School in Sham Shui Po and Fan Ling Assembly of God Church Primary School are among three schools ordered closed in the past nine days.

In Ying Wah, 32 students and two staff members have come down with flu-like symptoms — including fever, coughs and sore throats — since February 8.

An 11-year-old boy was admitted to Queen Elizabeth Hospital and discharged and a nine-year-old boy was admitted to a private hospital and was in a stable condition. Both pupils tested positive for Influenza A.

In Fan Ling 37 students, 24 boys and 13 girls, aged from six to 11, fell ill between February 6 and yesterday. An eight-year-old boy with Influenza B was in a stable condition at Alice Ho Miu Ling Nethersole Hospital.

A Centre for Health Protection spokesman said it advised the schools to suspend classes for disinfection to prevent the virus from spreading.

Meanwhile, there has been break of an influenza-like illness loon Tong's Alliance Primary Sc fecting 19 students and one staff

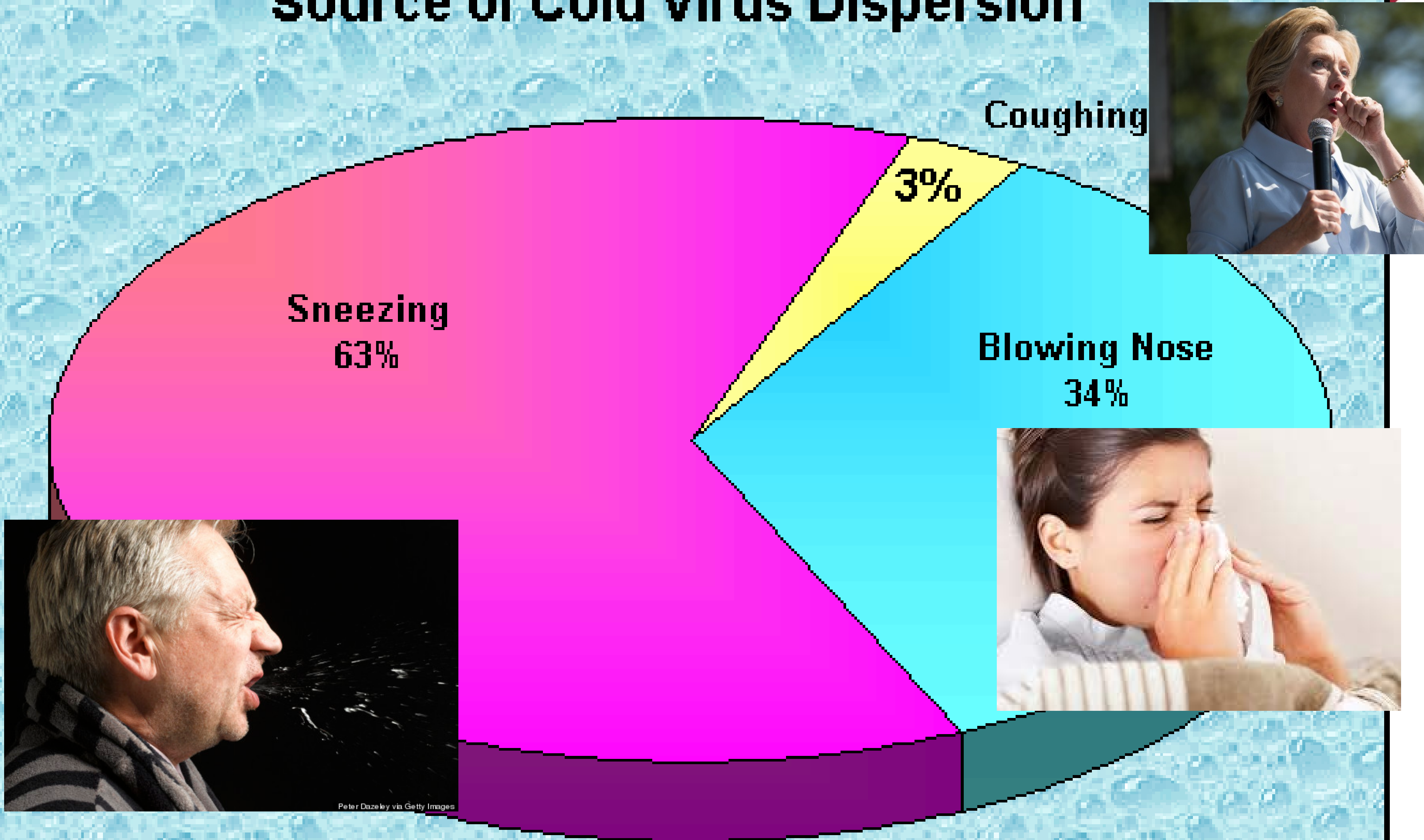
Six males and 14 females, ag six to 32, displayed symptoms February 8 and Saturday b needed hospitalization.

Center officials have visited th to give advice to staff.

Gifted Talent College (Prim tion) in Mong Kok was clo Monday after 27 students and veloped influenza-like symptom

nickkita.lau@singtaonewscorp.com

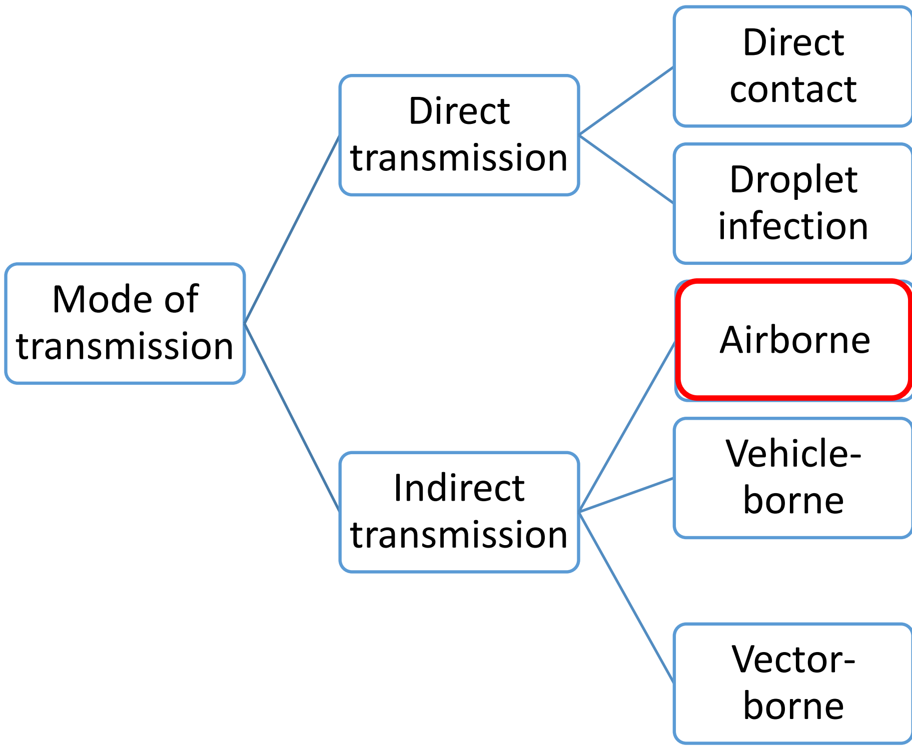
Source of Cold Virus Dispersion

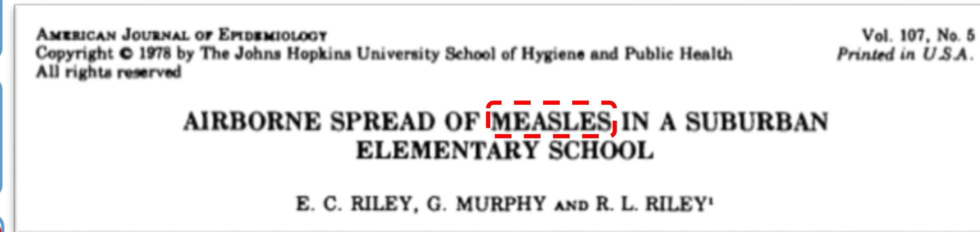


Ref. Buckland, et al 1964

Transmission modes of infectious diseases

Airborne transmission diseases: Tuberculosis, Measles, Influenza, Smallpox, and SARS



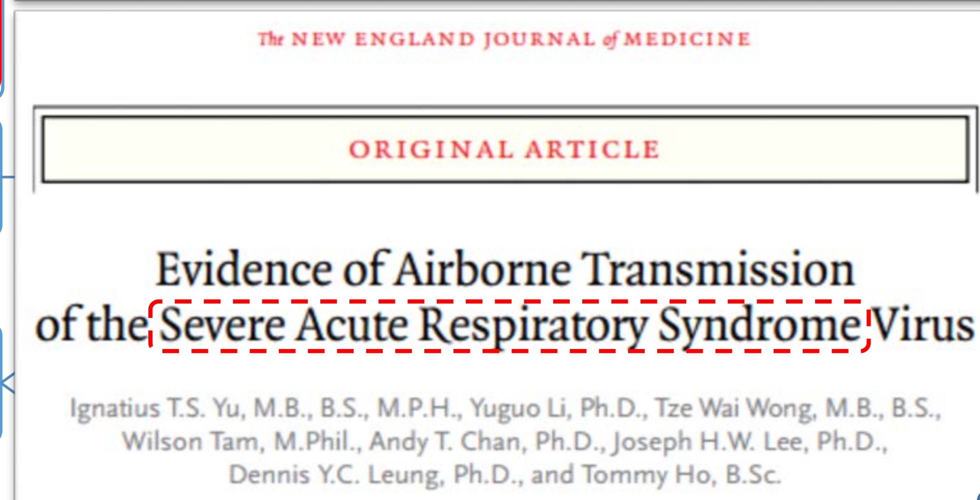


AMERICAN JOURNAL OF EPIDEMIOLOGY
Vol. 107, No. 5

Printed in U.S.A.

AIRBORNE SPREAD OF MEASLES IN A SUBURBAN ELEMENTARY SCHOOL

E. C. RILEY, G. MURPHY AND R. L. RILEY[1]



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Evidence of Airborne Transmission of the Severe Acute Respiratory Syndrome Virus

Ignatius T.S. Yu, M.B., B.S., M.P.H., Yuguo Li, Ph.D., Tze Wai Wong, M.B., B.S., Wilson Tam, M.Phil., Andy T. Chan, Ph.D., Joseph H.W. Lee, Ph.D., Dennis Y.C. Leung, Ph.D., and Tommy Ho, B.Sc.

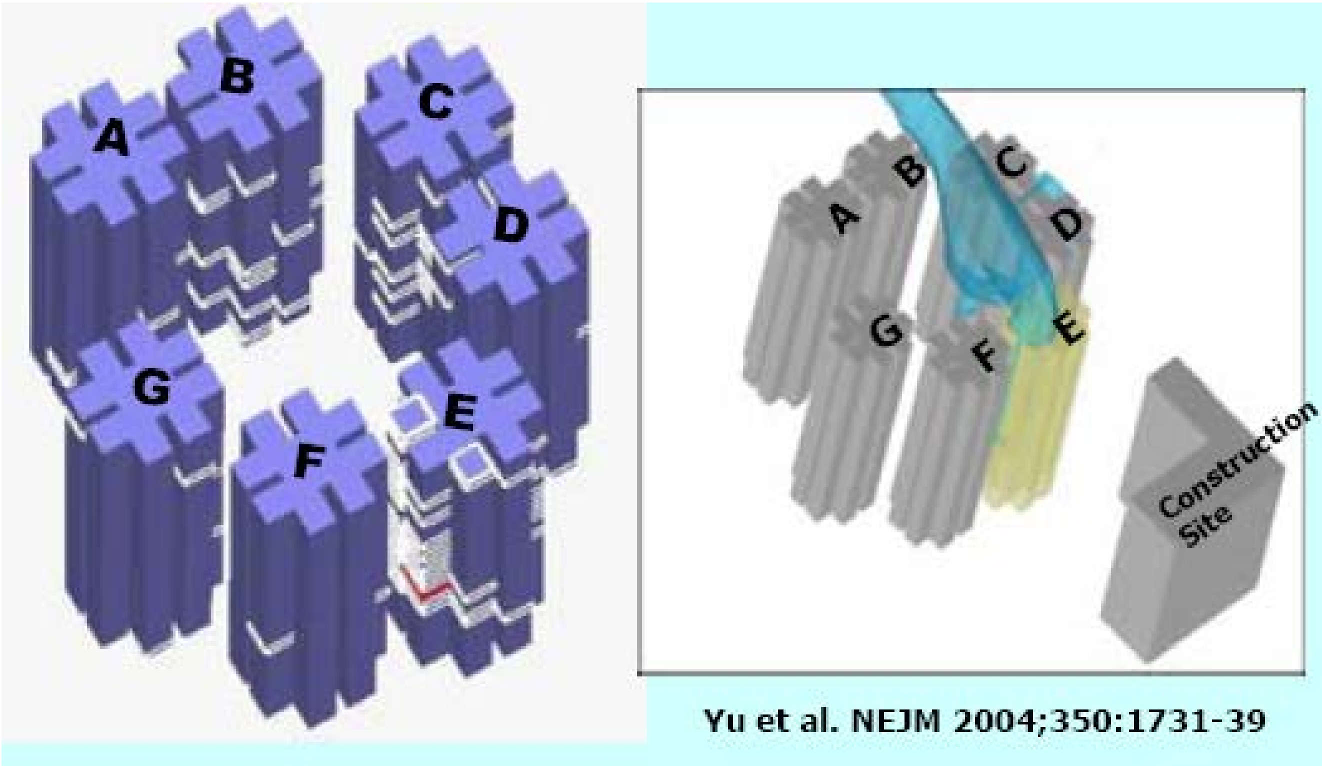
Identifying possible airborne transmission routes and assessing the risks are im

TB prevalence in Hong Kong

- There are about 7,000 notified cases of TB each year; About 1 out of every 1000 persons in Hong Kong develops the disease; 10 times higher than other developed countries;

Disease	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
SARS	NA	NA	610	979	150	16							1755
Tuberculosis	437	449	606	466	464	550	515	513	451	553	500	520	6024

SARS Spread Pattern at Amoy Garden



Yu et al. NEJM 2004;350:1731-39

Distribution of initial cases:

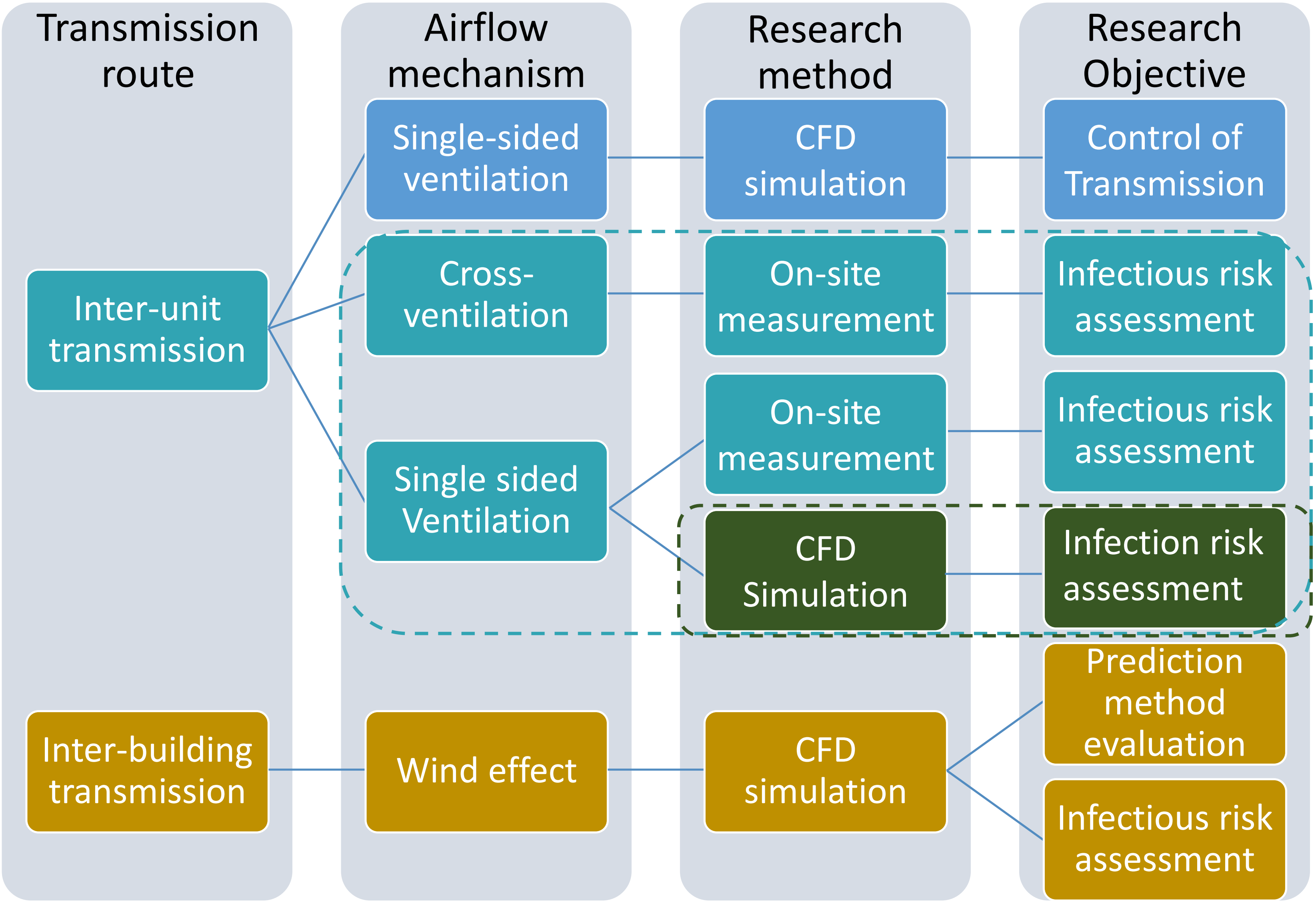
Block E (53%)-source — Inter-unit transmission

Block B (11%)
Block C (13%)
Block D (11%)
Other blocks (12%)

Inter-building transmission

Courtesy Prof. YG Li

Research outline



THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

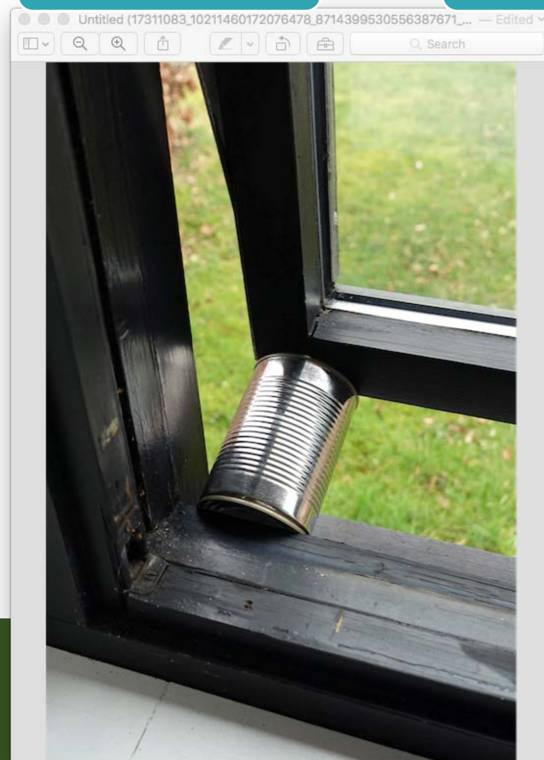
DEPARTMENT OF BUILDING SERVICES ENGINEERING

Inter-unit transmission

Single sided ventilation

On-site measurement

Infectious risk assessment

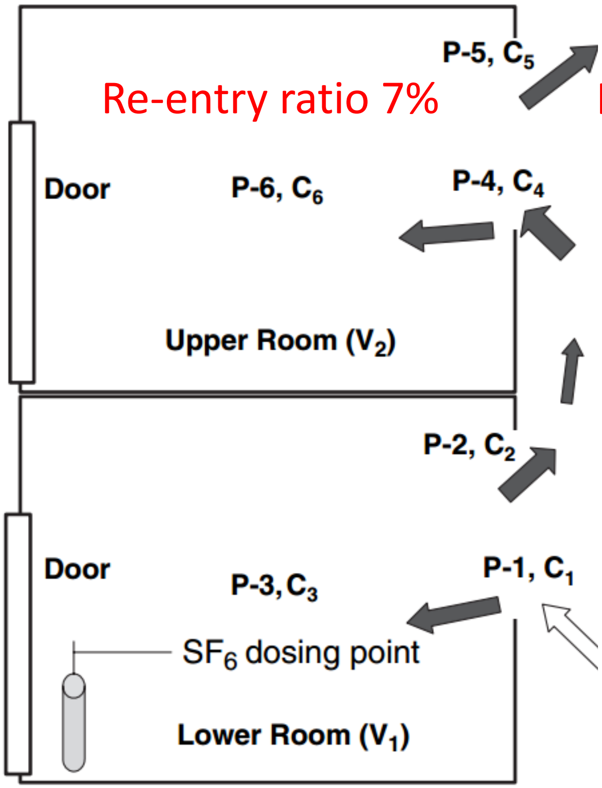


(Photo Curtesy, W. Bahnfleth)

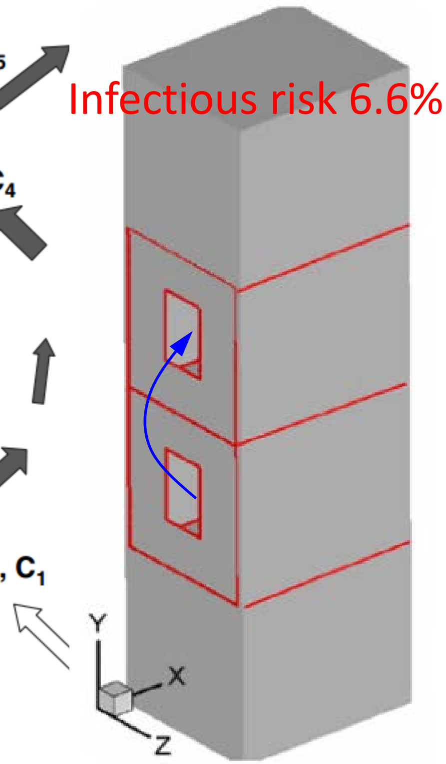
On-site measurement of inter-unit transmission and risk assessment

Building façade design

inter-unit transmission via single-side ventilation

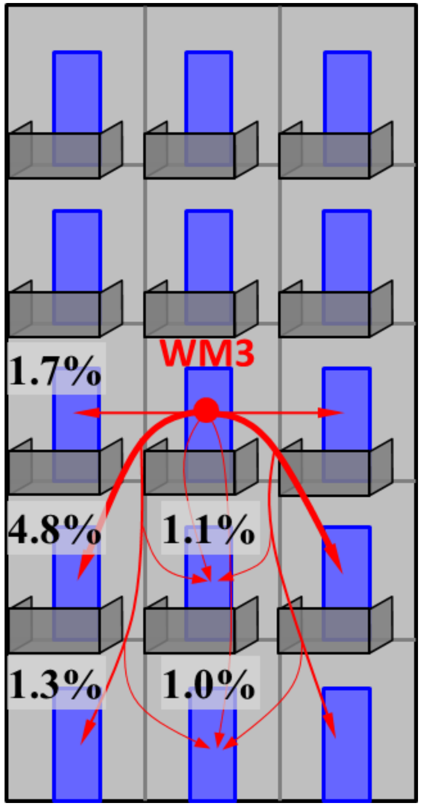


On-site measurements
Niu and Tung, 2008



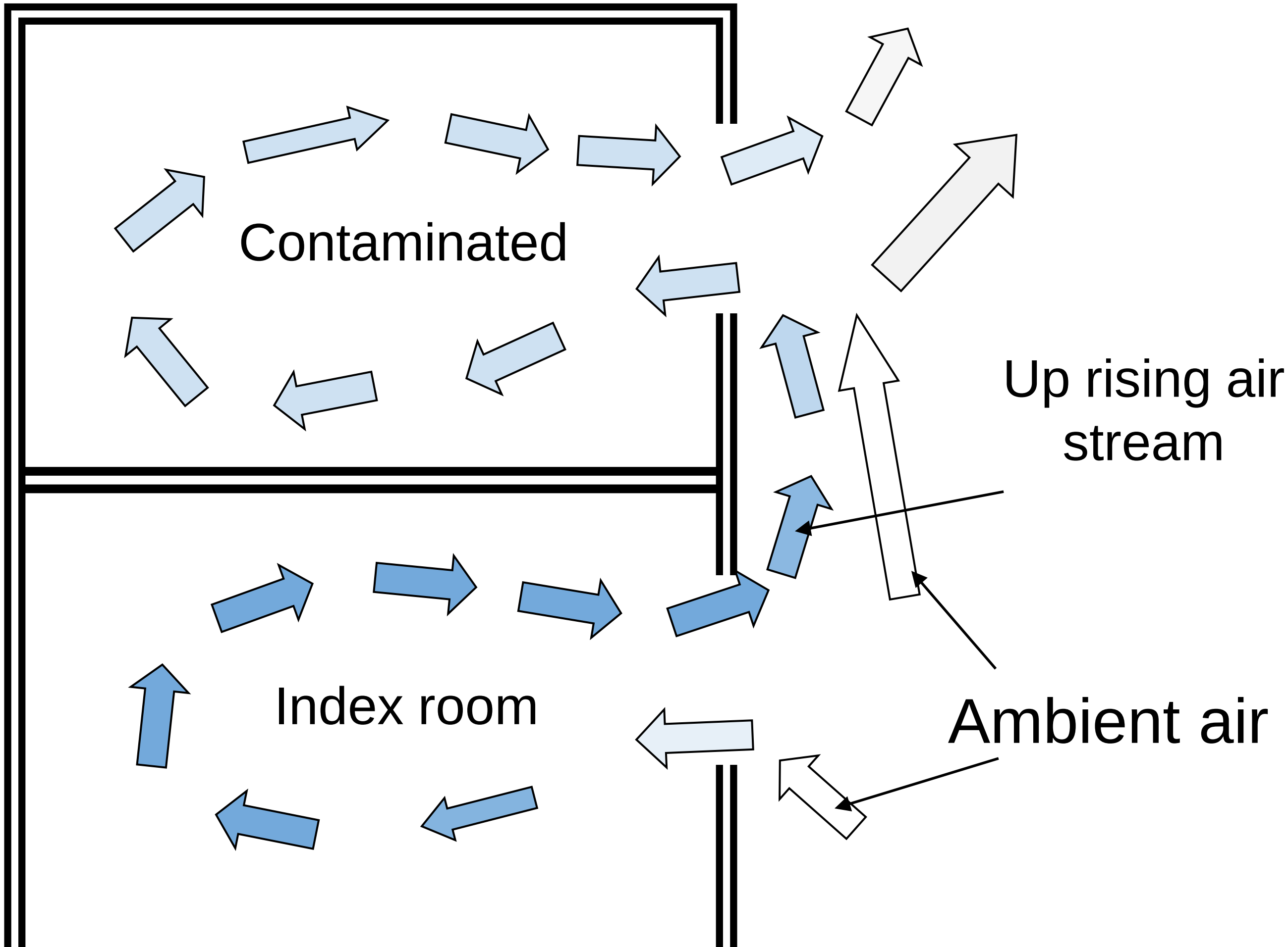
CFD simulations
Gao et al., 2008, 2009

Wind tunnel experiments
Liu et al., 2010, 2011

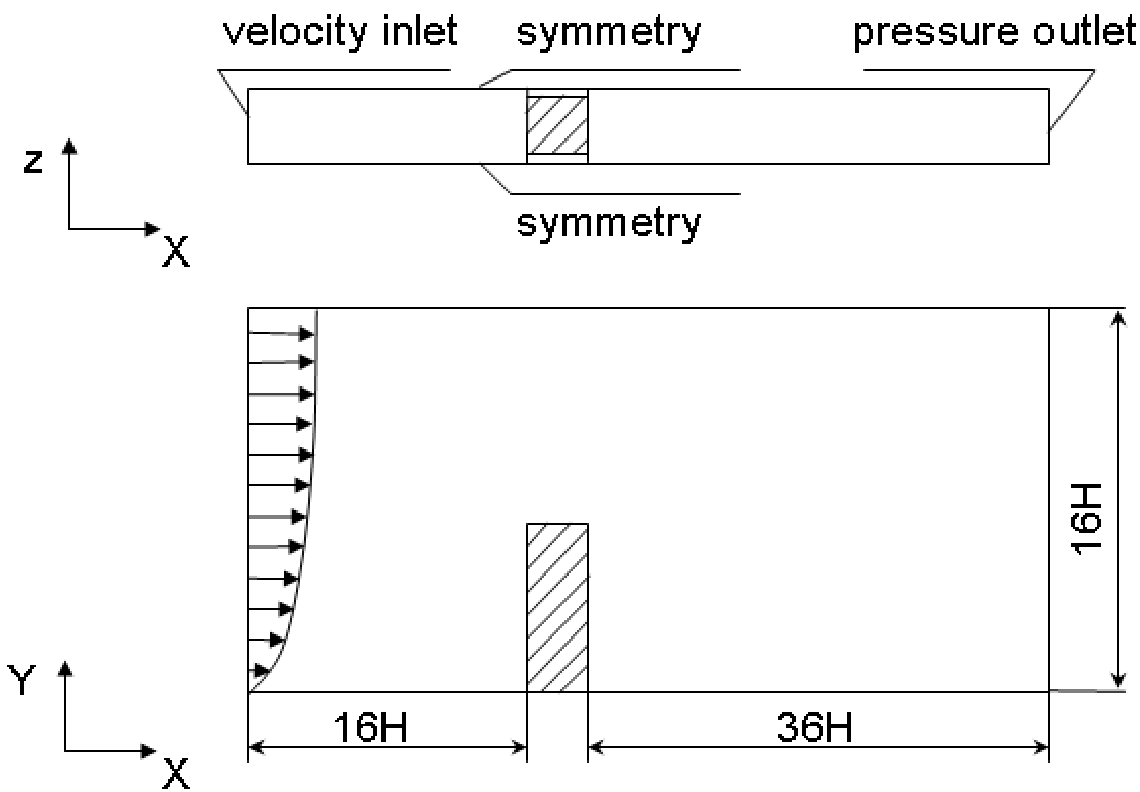


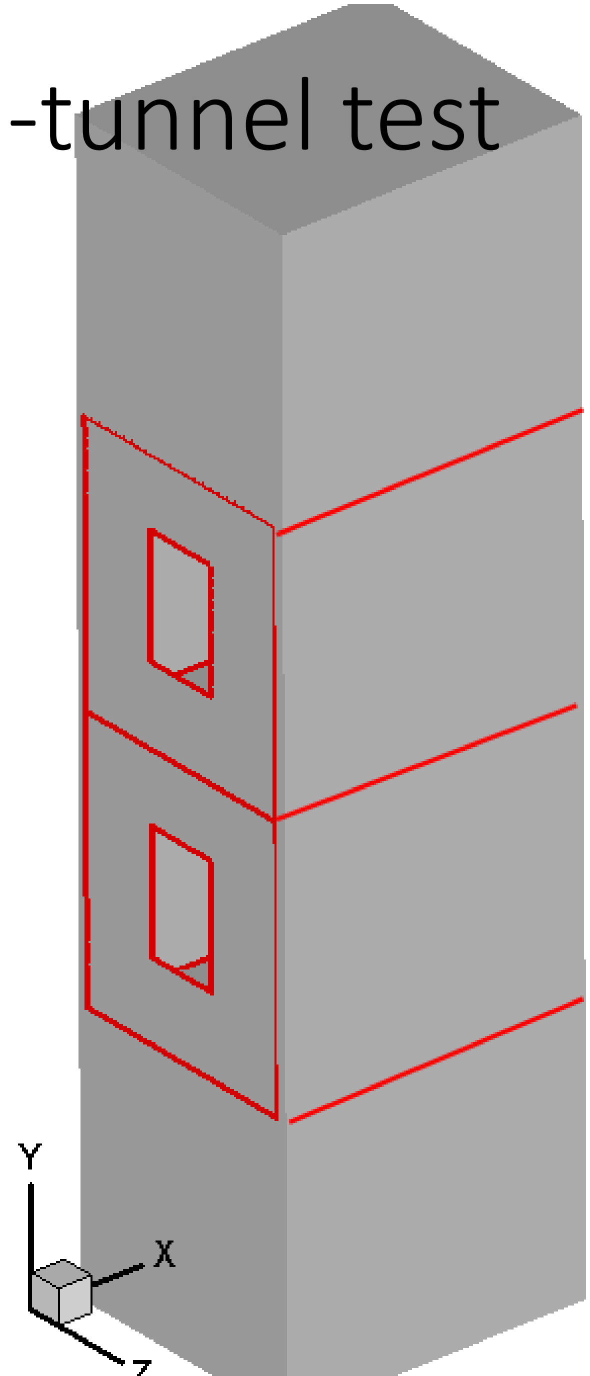
CFD simulations
Ai and Mak, 2013, 2014

- Airflow between flats via single-side open Windows



CFD simulation –virtual wind-tunnel test

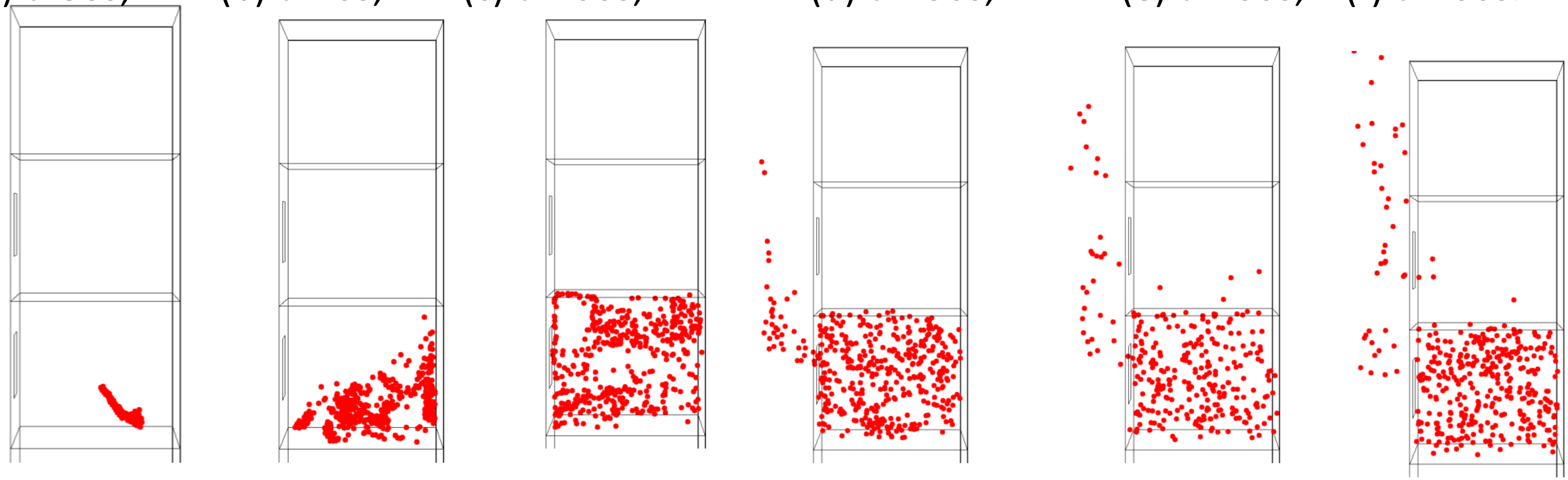




Droplets movement through open windows

- 1.0 μm particles from Lagrangian simulations
- 500 particles are generated in the center of the lower floor:

(a) t=30s; (b) t=70s; (c) t=100s; (d) t=130s; (e) t=160s; (f) t=200s.



$$\frac{d\vec{u}_p}{dt} = \vec{F}_{drag} + \vec{F}_{grav} + \vec{F}_{addi}$$

The infection risks via open windows

- Mean risk of infection calculated from Wells-Riley equation

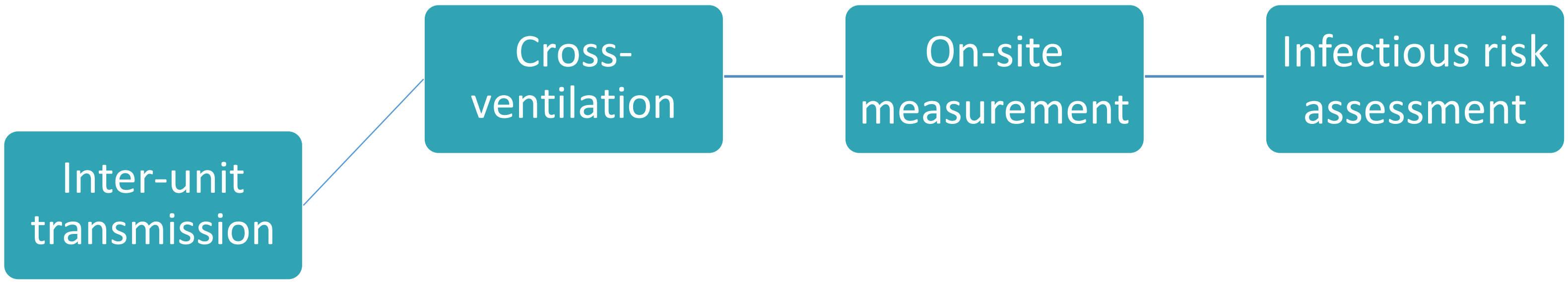
$$P = C/S = 1 - \exp(-N_q) = 1 - \exp -[Iq/(Q \cdot p\ t)]$$

- Based upon 8-hour exposure, using TB as the pathogen
- Single-side ventilation conditions (*Gao et al, 2007, Building and Environment*)

Ambient wind speed (m/s)	0.1	0.5	1.0	2.0	4.0
Mean risk of infection (second floor, source)	30%	28%	29%	31%	46%
Mean risk of infection (third floor)	2.0%	3.4%	3.5%	6.6%	1.7%

The Hong Kong Polytechnic University
香港理工大學

Department of Building Services Engineering
屋宇設備工程學系



On-site measurement of inter-unit transmission and risk assessment

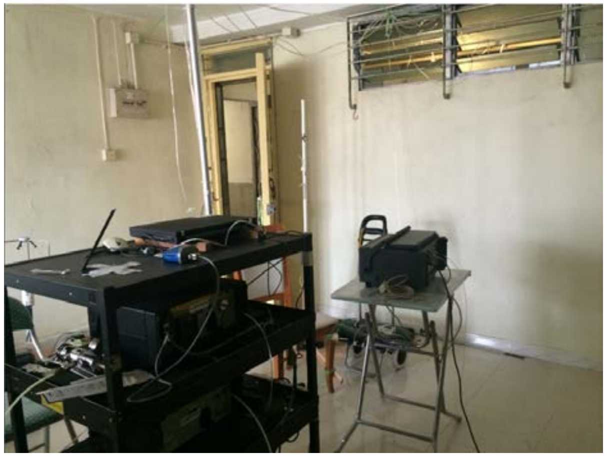
On-site measurement

Measurement site: Block 11, Pak Tin Estate, Hong Kong

Measurement period: March-May, 2015

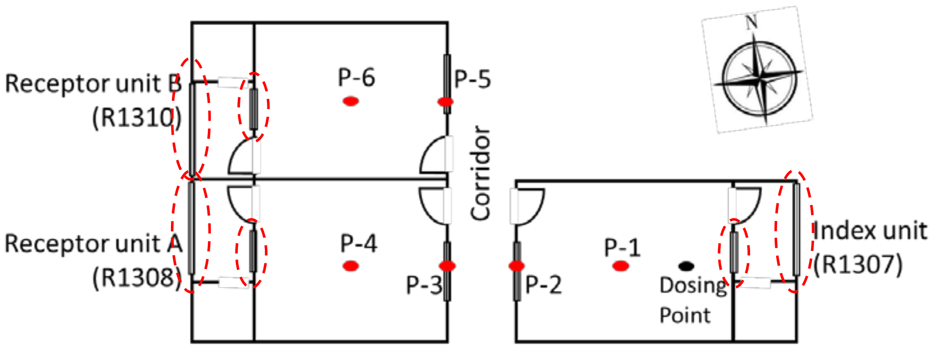
- Tracer gas techniques
  - CO_2 Concentration decay method for ACH calculation
  - SF_6 Continuous constant injection for tracing pollutant dispersion
- Wind measurement on roof top

Three adjacent units for measurements



Measurement scenarios and instruments

- Scenario 1
  Close window mode driven by air infiltration
- Scenario 2
  Open window mode driven by cross-ventilation



Instruments
- SF_6 dosing (constant rate) and sampling:
  B&K Multi-gas Monitor 1302&1303
- CO_2 dosing(explosive release) and samplin
  TSI Q-Trak, Telaire CO_2 Sensor
- Wind speed measurement:
  Young UVW anemometers

Data analysis – mass balance modeling

Air change rate calculation

Assuming a steady airflow and well-mixed indoor air

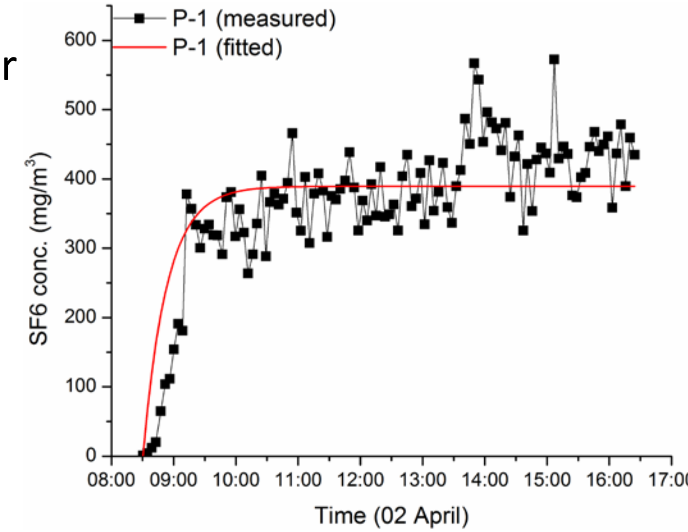
Mass balance equation of tracer gas

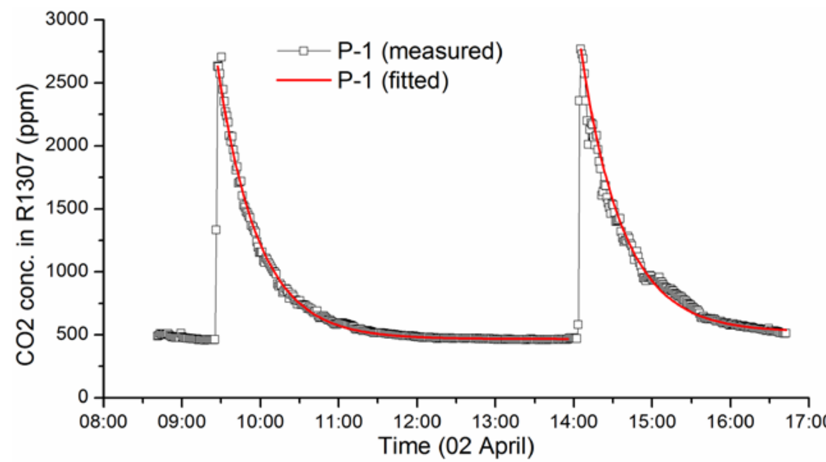
$$V\frac{dC}{dt} = E + Q_0C_0 - QC$$

The differential equation can be solved as

$$C = \left(C_i - \frac{E}{Q}\right)e^{\frac{-Qt}{V}} + \frac{E}{Q}$$

Using the statistic approach of least square fitting, air flow rate Q can be obtained by minimizing the sum deviation. (E = 0 for CO_2)





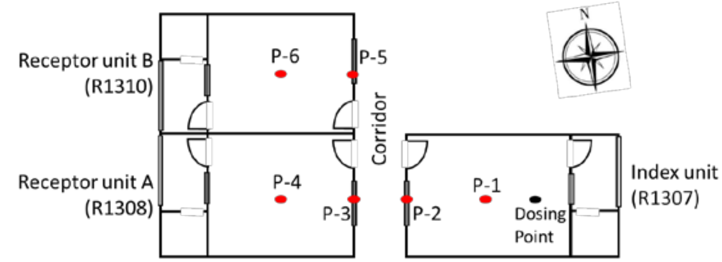
Infectious risks assessment

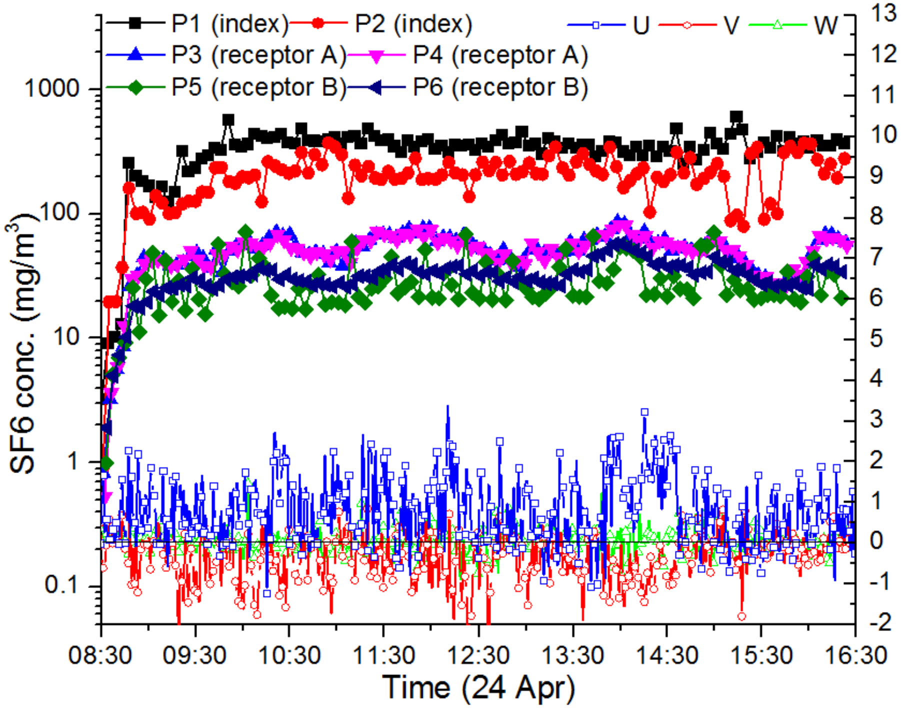
Wells–Riley model

Index unit $P = \frac{C}{S} = 1 - e^{\frac{-Iqpt}{Q}}$

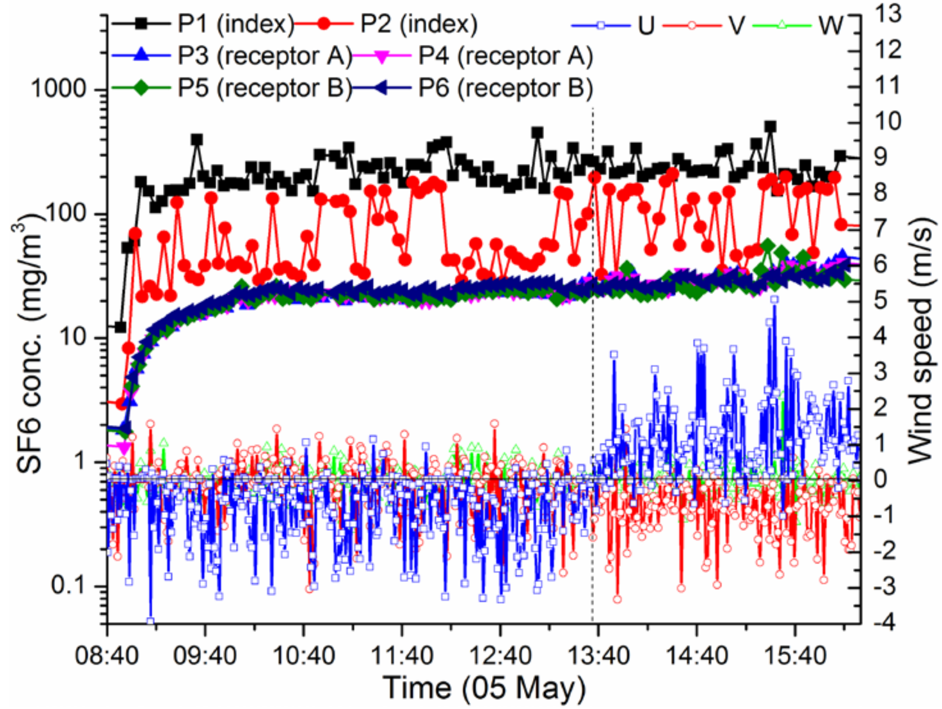
Receptor unit $P = 1 - e^{\frac{-IqptM}{Q}}$ $M_{i\text{-}j}=C_j/C_i$

Inter-unit tracer gas dispersion





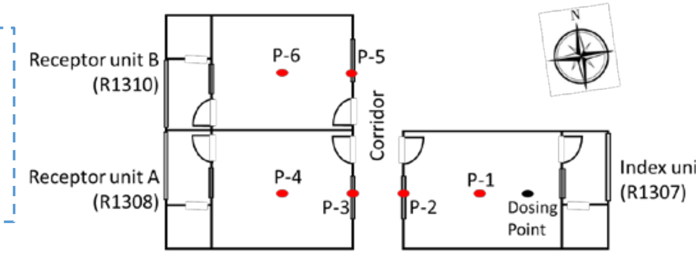
Close window scenario

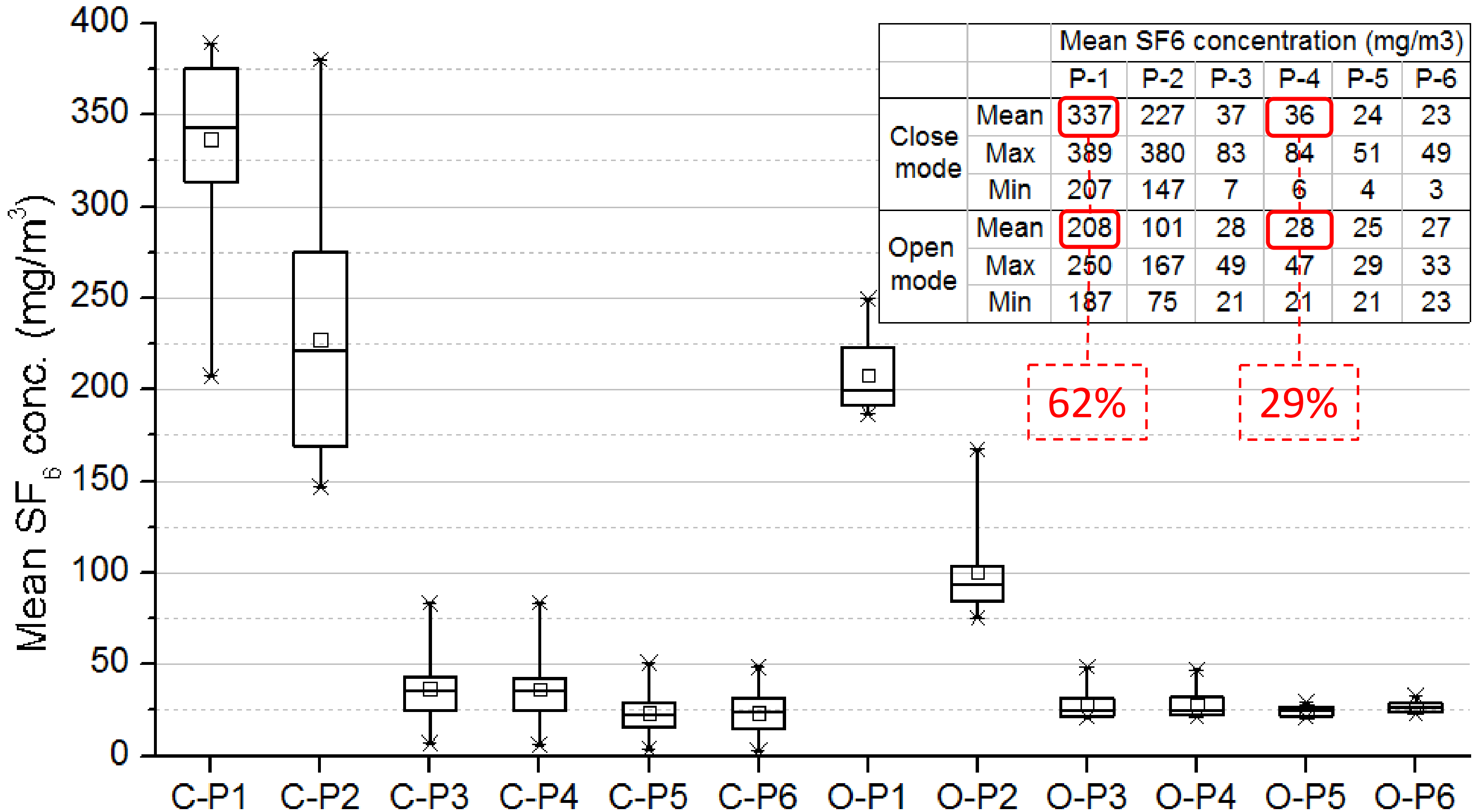


Open window scenario

Inter-unit tracer gas dispersion

- One order lower of magnitude in receptor units
- Higher concentrations in Close window scenario
- Well-mixed condition

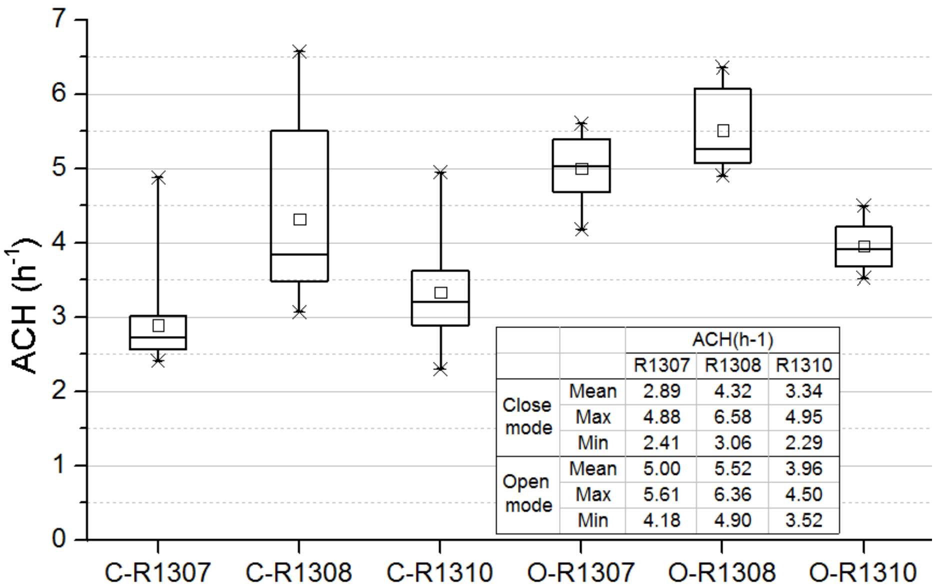




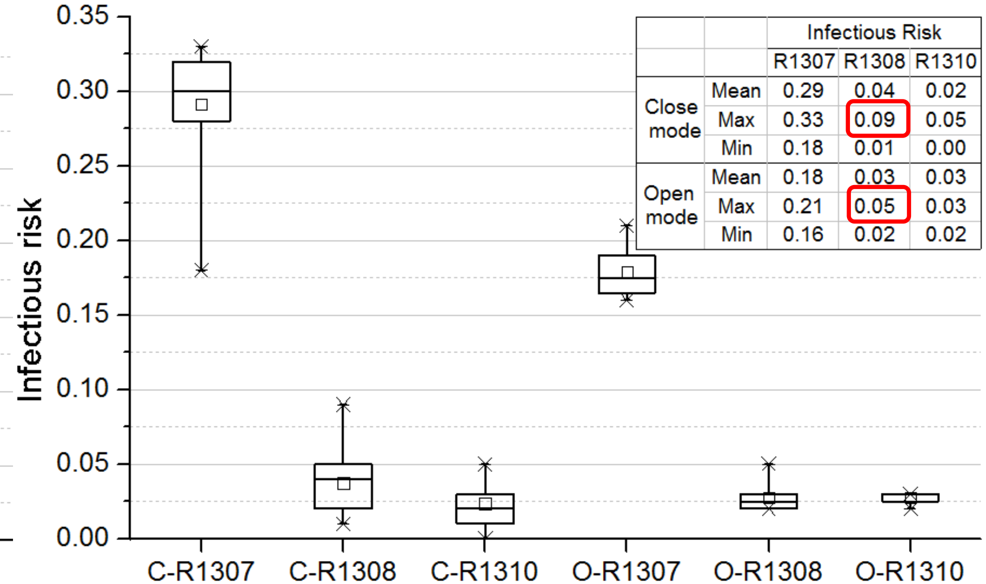
		Mean SF6 concentration (mg/m3)					
		P-1	P-2	P-3	P-4	P-5	P-6
Close mode	Mean	337	227	37	36	24	23
	Max	389	380	83	84	51	49
	Min	207	147	7	6	4	3
Open mode	Mean	208	101	28	28	25	27
	Max	250	167	49	47	29	33
	Min	187	75	21	21	21	23

Infectious risk of inter-unit dispersion

$R=M_{i\text{-}j}\cdot[(ACH)_j/(ACH)_i]$ Reentry ratio: 16%



		ACH(h-1)		
		R1307	R1308	R1310
Close mode	Mean	2.89	4.32	3.34
	Max	4.88	6.58	4.95
	Min	2.41	3.06	2.29
Open mode	Mean	5.00	5.52	3.96
	Max	5.61	6.36	4.50
	Min	4.18	4.90	3.52



		Infectious Risk		
		R1307	R1308	R1310
Close mode	Mean	0.29	0.04	0.02
	Max	0.33	0.09	0.05
	Min	0.18	0.01	0.00
Open mode	Mean	0.18	0.03	0.03
	Max	0.21	0.05	0.03
	Min	0.16	0.02	0.02

***ACH*:** >3 Close window scenario (leaky building*); = 5 Open window scenarios.

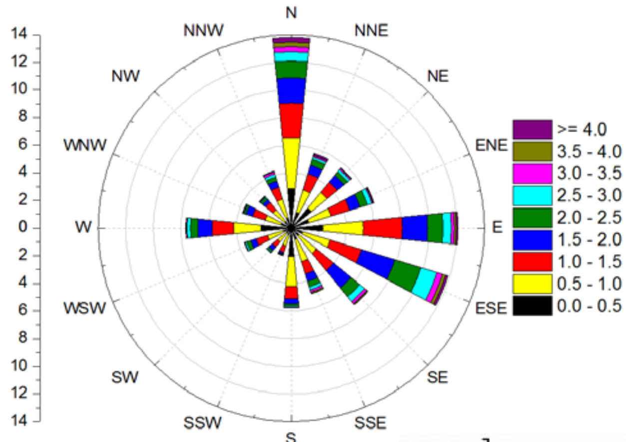
Cross-infection risk: Horizontal: 9% Close window; 5% Open window;

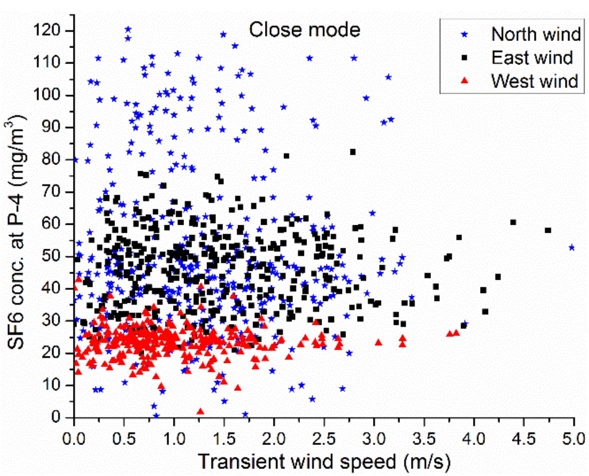
versus vertical 6.6% single-sided ventilation

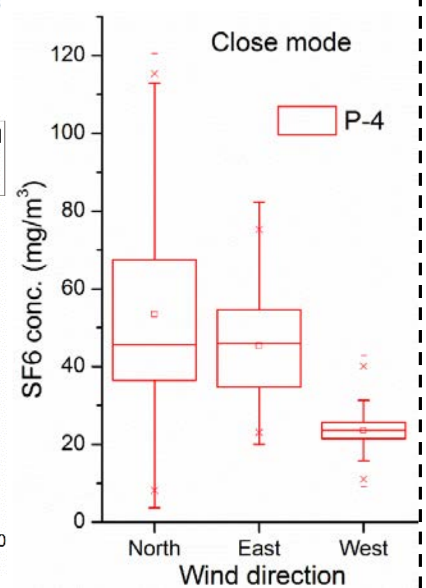
*Recommended air leakage is under 0.7–0.8 *ACH* in the ASHRAE handbook for energy saving.

Correlation analysis-SF_6 vs wind direction

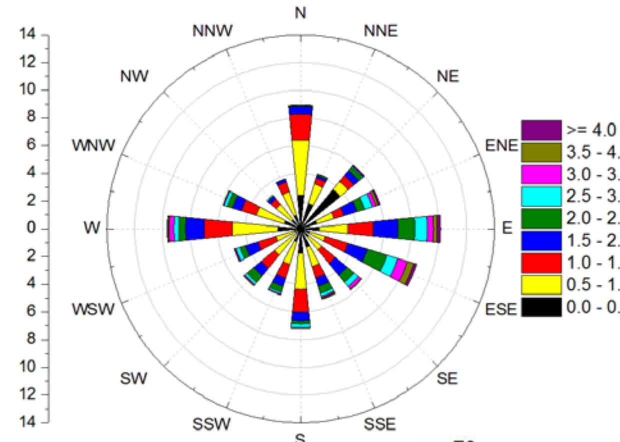
- Close window scenario

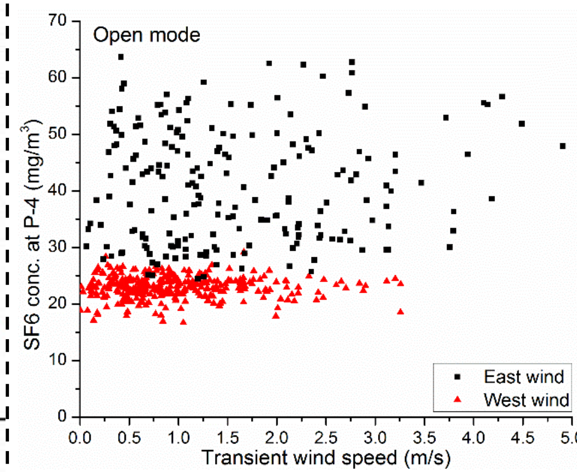


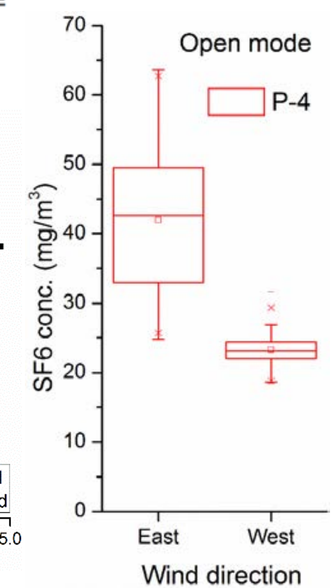




- Open window scenario







Correlation analysis-SF_6 vs wind speed

SPSS correlation coefficient		SF_6 concentration					
		Close window scenario			Open window scenario		
		Index $C_1(t)$	Receptor A $C_4(t)$	Receptor B $C_6(t)$	Index $C_1(t)$	Receptor A $C_4(t)$	Receptor B $C_6(t)$
Wind speed v	$v(t)$	-0.070*	0.146**	0.075**	-0.110**	0.255**	0.202**
	$\bar{v}(t\text{-}5,t)$	-0.108**	0.247**	0.124**	-0.212**	0.441**	0.416**
	$\bar{v}(t\text{-}10,t)$	-0.109**	0.285**	0.146**	-0.224**	0.517**	0.505**
	$\bar{v}(t\text{-}15,t)$	-0.124**	0.305**	0.146**	-0.227**	0.558**	0.548**
	$\bar{v}(t\text{-}20,t)$	-0.124**	0.313**	0.150**	-0.233**	0.583**	0.585**
	$\bar{v}(t\text{-}25,t)$	-0.123**	0.319**	0.150**	-0.239**	0.601**	0.597**
	$\bar{v}(t\text{-}30,t)$	-0.121**	0.330**	0.155**	-0.254**	0.607**	0.605**
	$\bar{v}(t\text{-}40,t)$	-0.126**	0.341**	0.164**	-0.250**	0.624**	0.628**
	$\bar{v}(t\text{-}50,t)$	-0.120**	0.358**	0.173**	-0.251**	0.645**	0.638**
	$\bar{v}(t\text{-}60,t)$	-0.118**	0.375**	0.185**	-0.256**	0.659**	0.646**
	$\bar{v}(t\text{-}90,t)$	-0.115**	0.399**	0.206**	-0.238**	0.675**	0.652**
	$\bar{v}(t\text{-}120,t)$	-0.111**	0.421**	0.221**	-0.237**	0.677**	0.650**
	$\bar{v}(t\text{-}150,t)$	-0.109**	0.420**	0.227**	-0.220**	0.675**	0.648**

*. Correlation is significant at the 0.05 level (2-tailed).

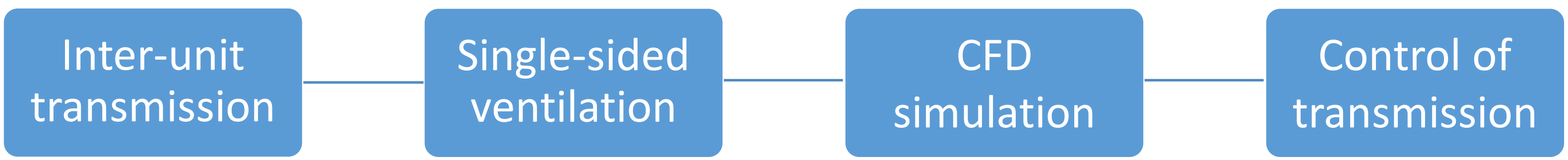
**. Correlation is significant at the 0.01 level (2-tailed).

Open > Close

Receptor > Index

$\bar{v}(t\text{-}N,t) > v(t)$

N=1400 for close
N=700 for open



Control of inter-unit transmission caused by single-sided ventilation

Control of inter-unit dispersion using mechanical exhaust

Two-way airflow of single-sided natural ventilation

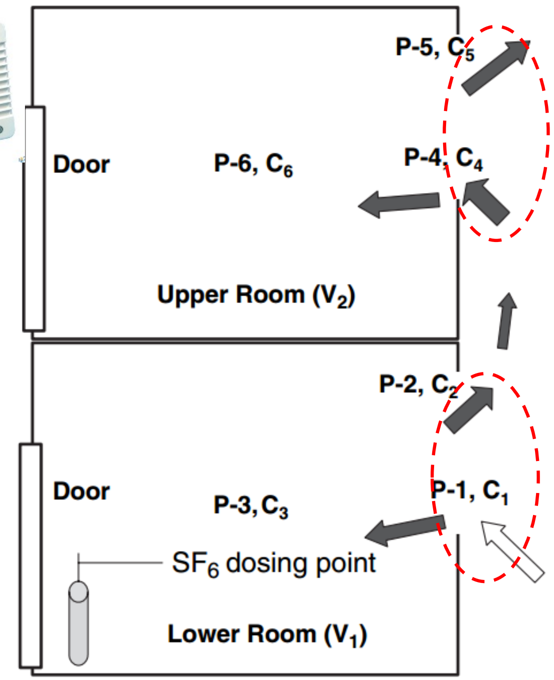
↓

Inter-unit cross-contamination

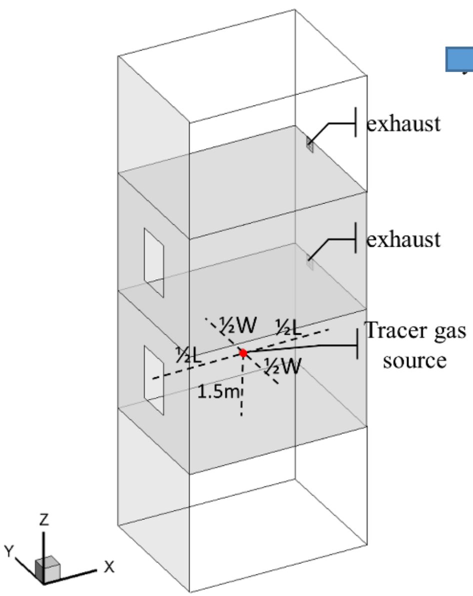
Mechanical exhaust (ME)

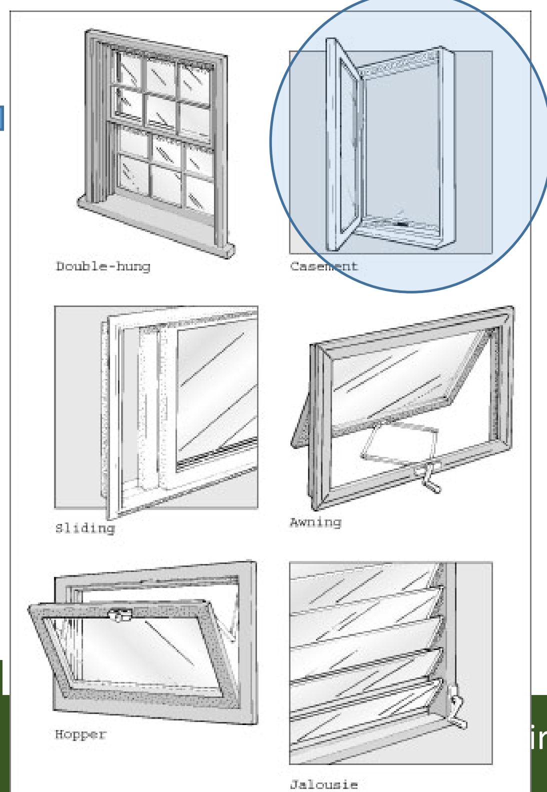
↓

Two-way airflow → One-way inflow



[Niu and Tung, Indoor Air, 2008]





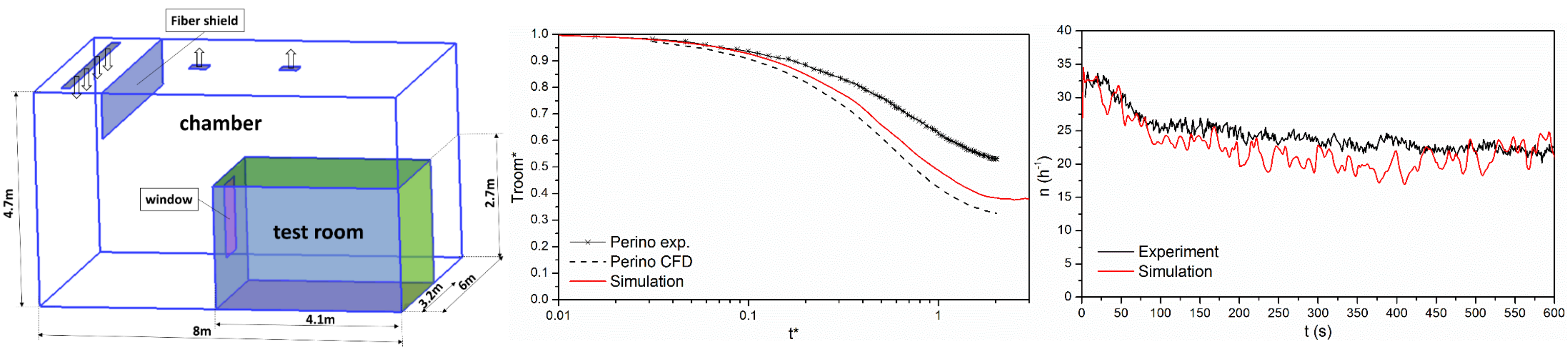
- Pure buoyancy effect was considered.
- Indoor–outdoor temperature ΔT was fixed at 5 °C.

Numerical method and Validation

Numerical models

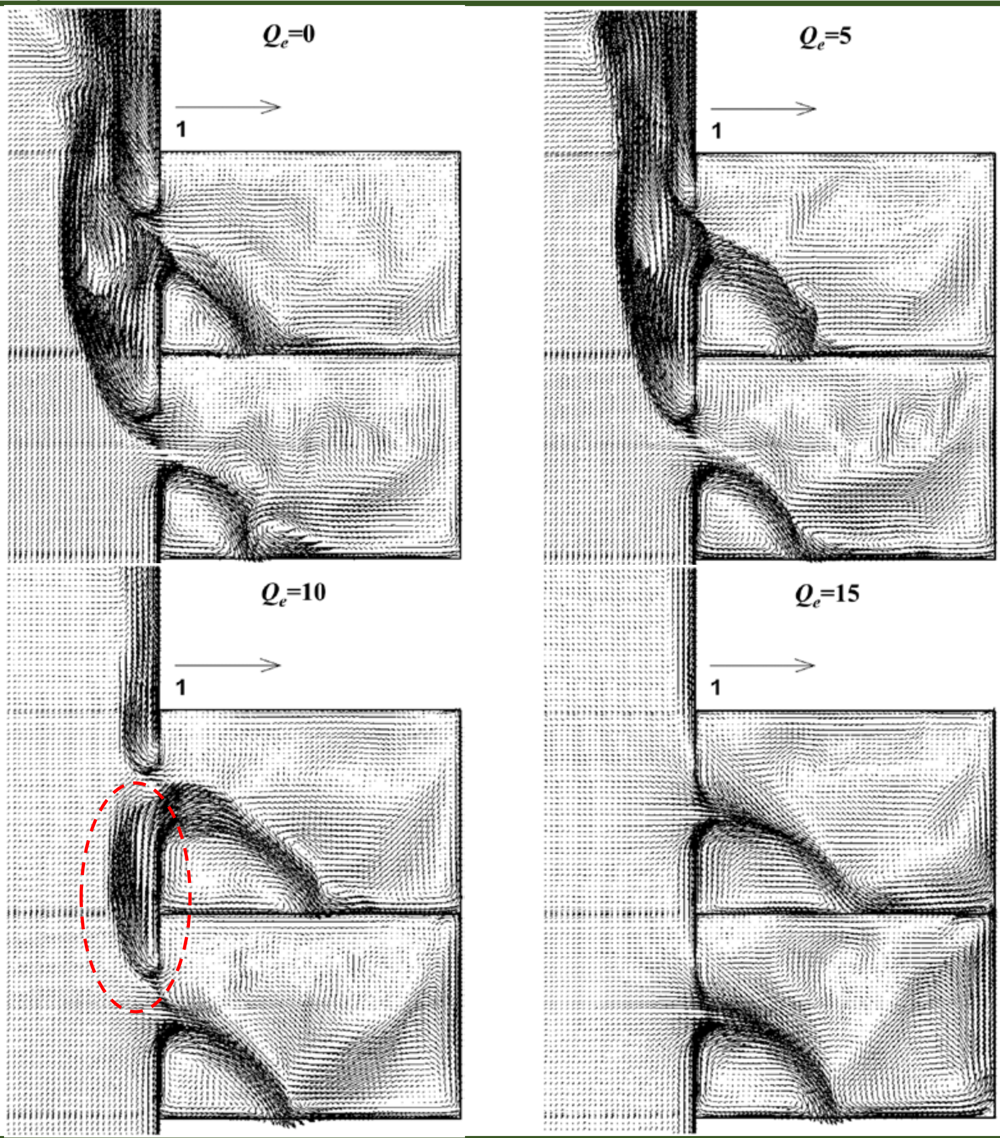
- ✓ Turbulence model: RNG k-ε model including low-Reynolds effect.
- ✓ Near-wall modeling: Enhanced wall treatment with a two-layer model ($y^+<5$).
- ✓ Full buoyancy effects in the generation of ε.
- ✓ Discretization scheme: the convection term, the second order upwind scheme;
  the diffusion term, the central difference scheme.
- ✓ Pressure–velocity coupling: SIMPLE algorithm.

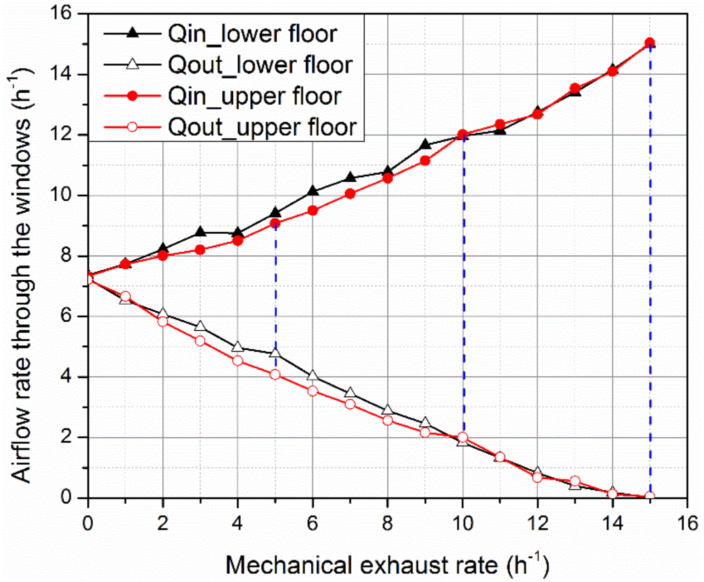
Validation with experiments of buoyancy driven single-sided natural ventilation



[Heiselberg and Perino 2010; Perino 2009]

Effect of ME on airflow



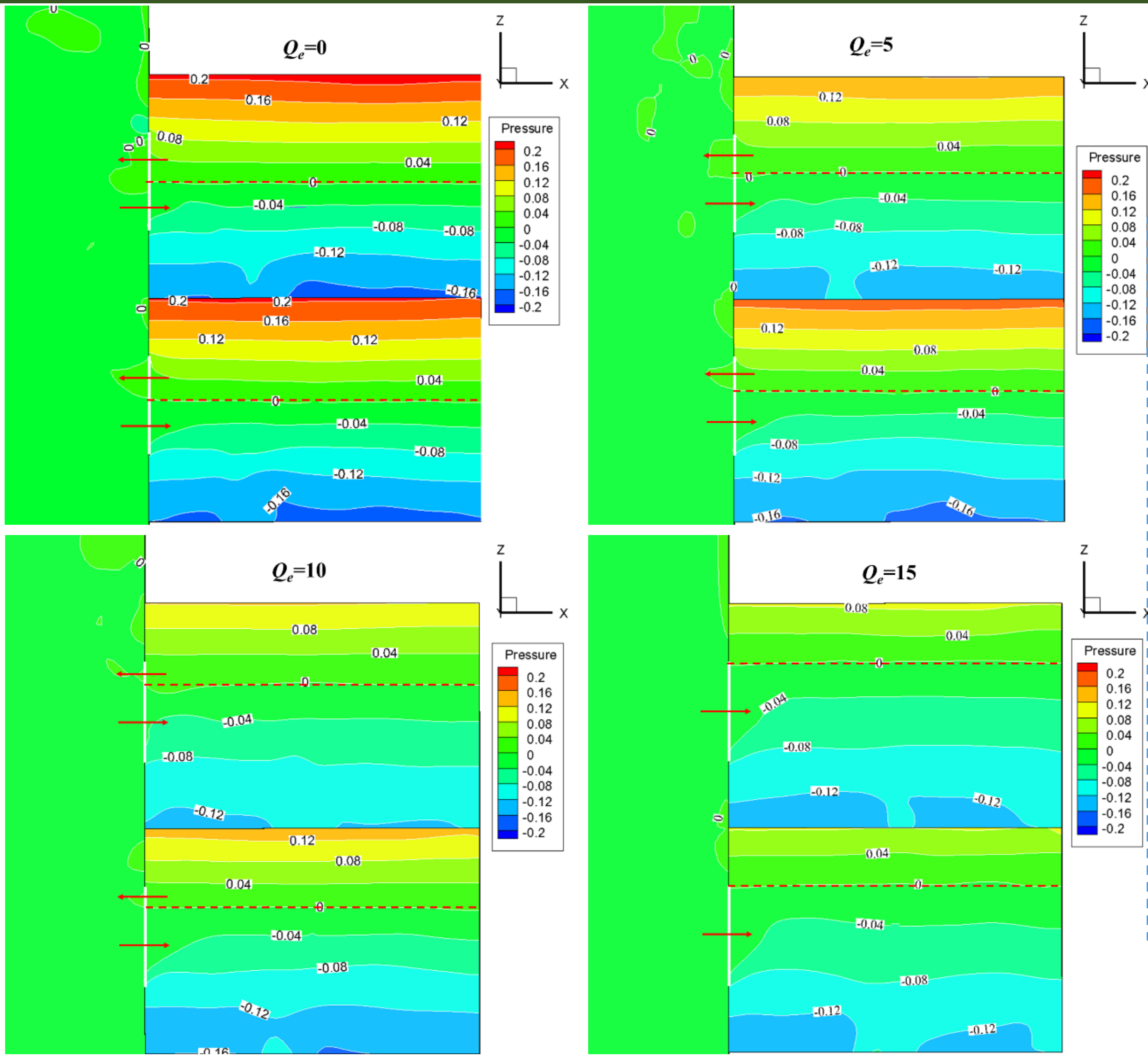


ME will increase inflows and decrease outflows.

Q_e=15 h^{-1}, outflows are eliminated.

Q_e=10 h^{-1}, the outflows from windows are more attached to the façade.

Pressure distribution for different ME rates



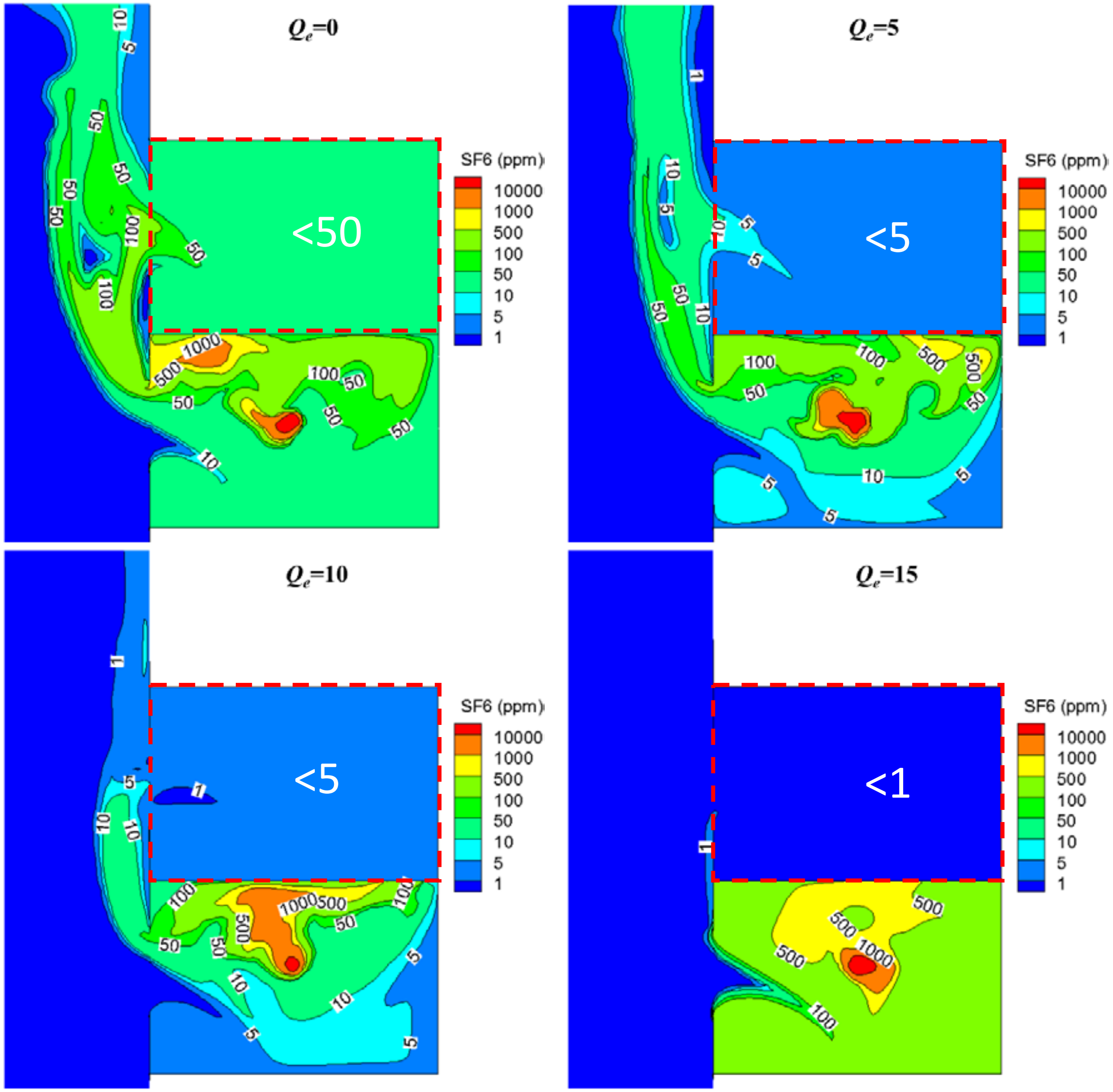
The neutral plane rises with the ME rate.

Above neutral plane: outflow
Below neutral plane: inflow

When the neutral plane rises above the top edge of the window, outflow will be eliminated.

Attached outflow is due to the small pressure difference.

Effect of ME on tracer gas dispersion



ME can significantly reduce the tracer gas concentration in the upper unit.

Small ME rate of 5 h^{-1} can reduce the concentration by one order of magnitude.

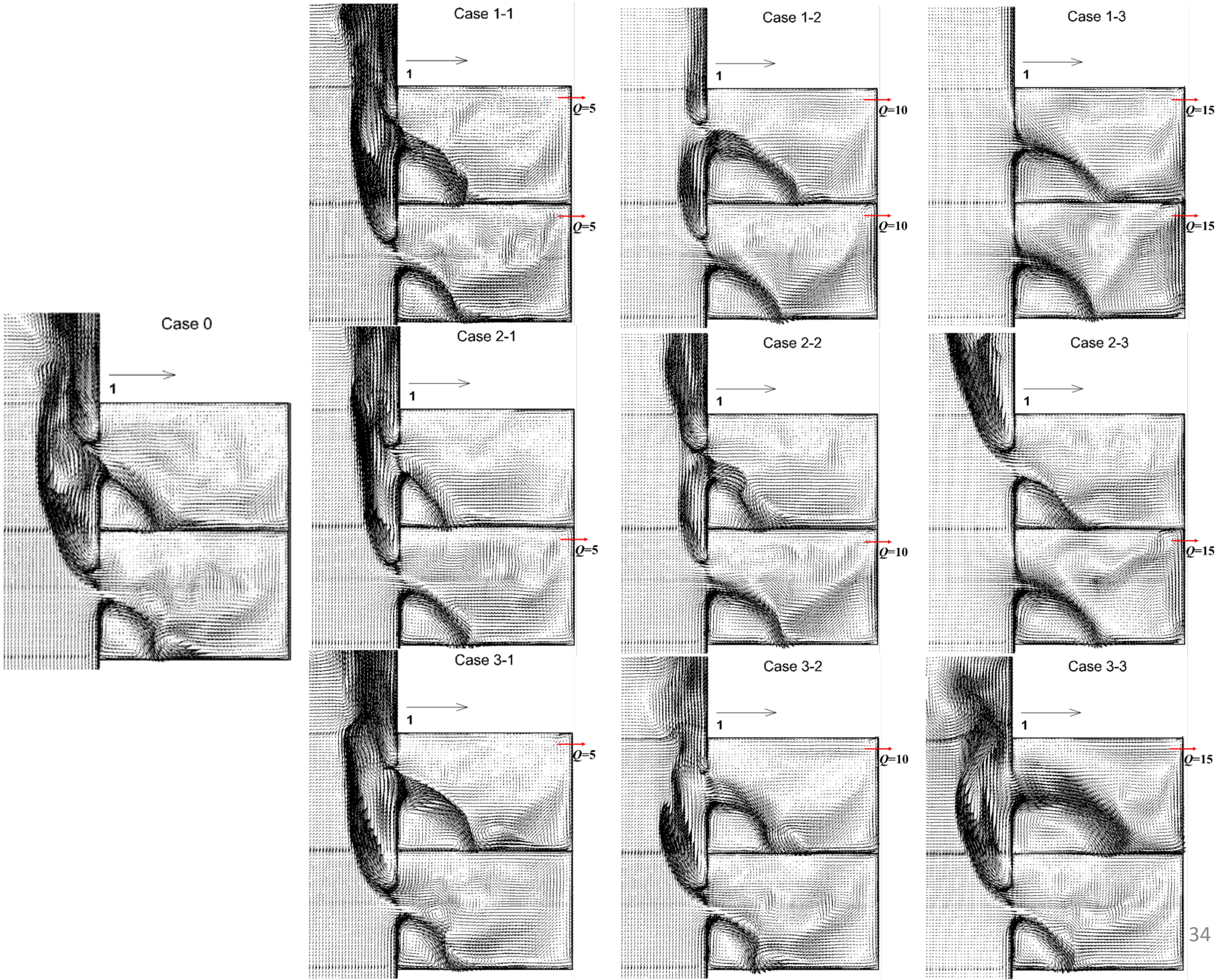
Q_e=10 h^{-1}, tracer gas concentration in upper unit is similar as Q_e=5 h^{-1}.

Different ME operation scenarios

- No central ME systems
- Household exhaust fans operating at a range of ach

Case No.	Boundary conditions: Mechanical exhaust (with: √ without: ×) Lower room	Mechanical exhaust (with: √ without: ×) Upper room	Mechanical exhaust rate Q_e (h^{-1}) Lower room	Mechanical exhaust rate Q_e (h^{-1}) Upper room	Simulation results: Lower room Inflow rate Q_{in} (h^{-1})	Lower room Outflow rate Q_{out} (h^{-1})	Upper room Inflow rate Q_{in} (h^{-1})	Upper room Outflow rate Q_{out} (h^{-1})
Case 0	×	×	0	0	7.38	7.49	6.56	6.52
Case 1-1	√	√	5	5	9.41	4.77	9.07	4.08
Case 1-2			10	10	11.96	1.83	12.01	2.00
Case 1-3			15	15	15.01	0.01	15.04	0.04
Case 2-1	√	×	5	0	9.84	4.72	7.05	7.07
Case 2-2			10	0	11.89	1.83	7.19	7.15
Case 2-3			15	0	14.98	0.00	7.11	7.45
Case 3-1	×	√	0	5	7.18	7.27	8.81	3.87
Case 3-2			0	10	7.22	7.18	11.27	1.29
Case 3-3			0	15	7.21	7.09	15.06	0.04

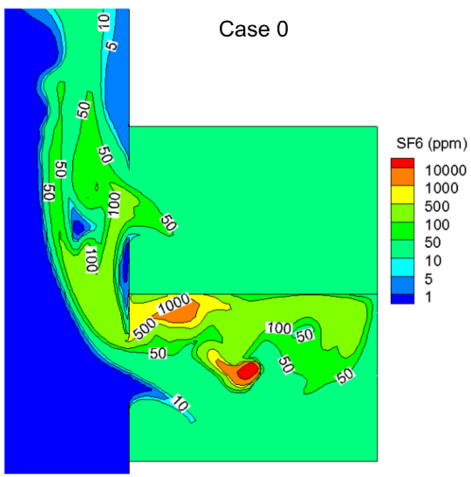
The window airflow rates of one unit are not affected by the ME condition of the adjacent unit

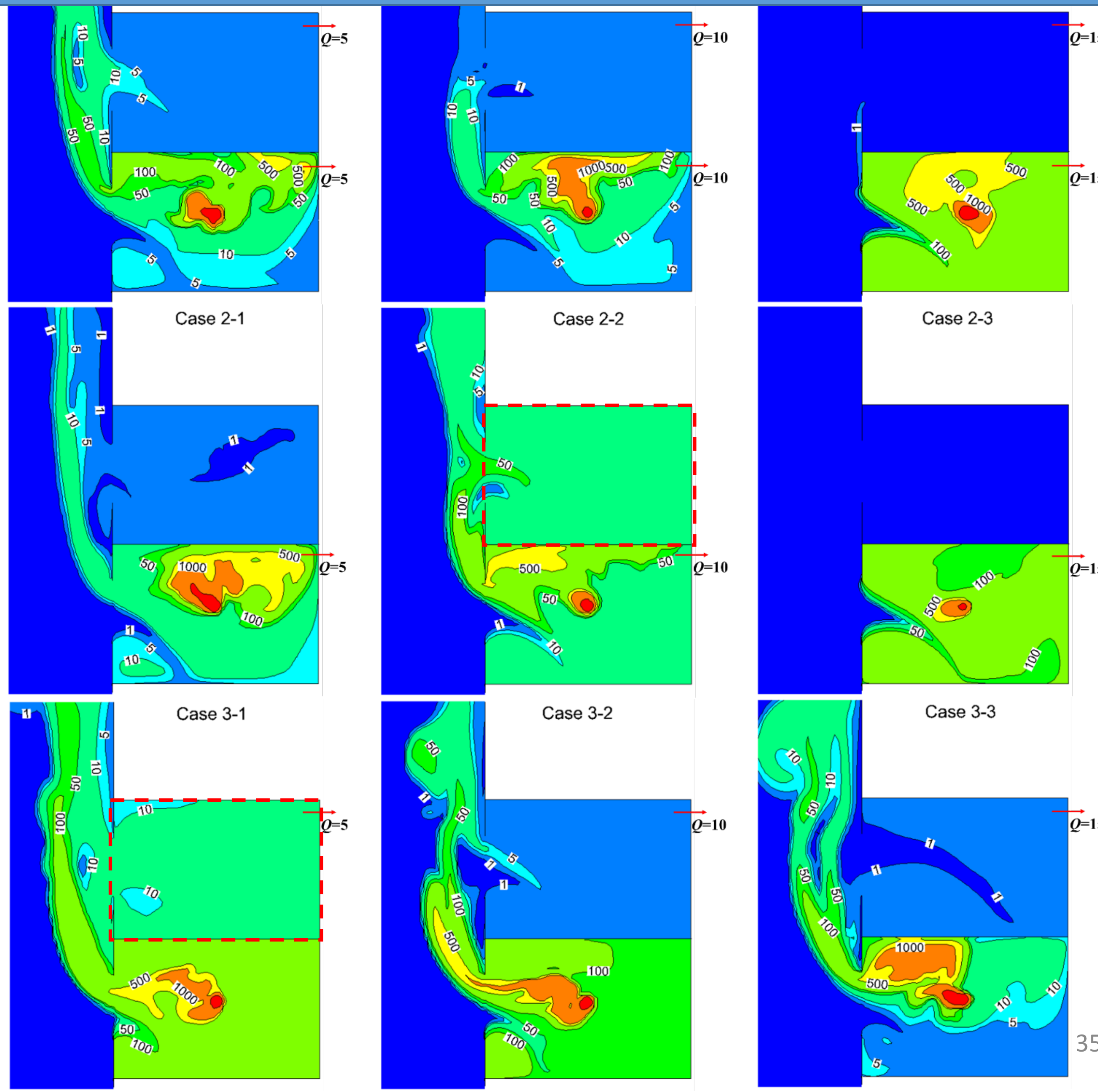


Case 0
1
Case 1-1
1
Q=5
Q=5
Case 1-2
1
Q=10
Q=10
Case 1-3
1
Q=15
Q=15
Case 2-1
1
Q=5
Case 2-2
1
Q=10
Case 2-3
1
Q=15
Case 3-1
1
Q=5
Case 3-2
1
Q=10
Case 3-3
1
Q=15

Central ME system is more effective

Case 2-2:
The concentration in upper unit is quite high due to the attached outflow of lower unit.





Case 3-1:
Low ME rate in upper unit increases the re-entry of tracer gas from lower unit.

Conclusions

- The airborne transmission routes in HRR environments were identified, and the infectious risk was assessed.

- On-site measurement verified the high risk of inter-unit dispersion caused by air infiltration.

- The possibility of utilizing mechanical exhaust to eliminate cross-contamination was examined.

- Recommendations building and ventilation designs and occupant behaviors/operation were stated.

Implications of these Mechanism studies

- provide insight into more effective intervention in control of the spread of infection I big cities.

- More effective use of natural and mechanical ventilation in an outbreak

-----Thank you for your attention.

Acknowledgements

- RGC and RFCID (now HMRF) Funding
- PhD students, Post-doctoral fellows: Thomas Tung, Naiping GAO, Yan Wu
- FCE and BSE matching funding