

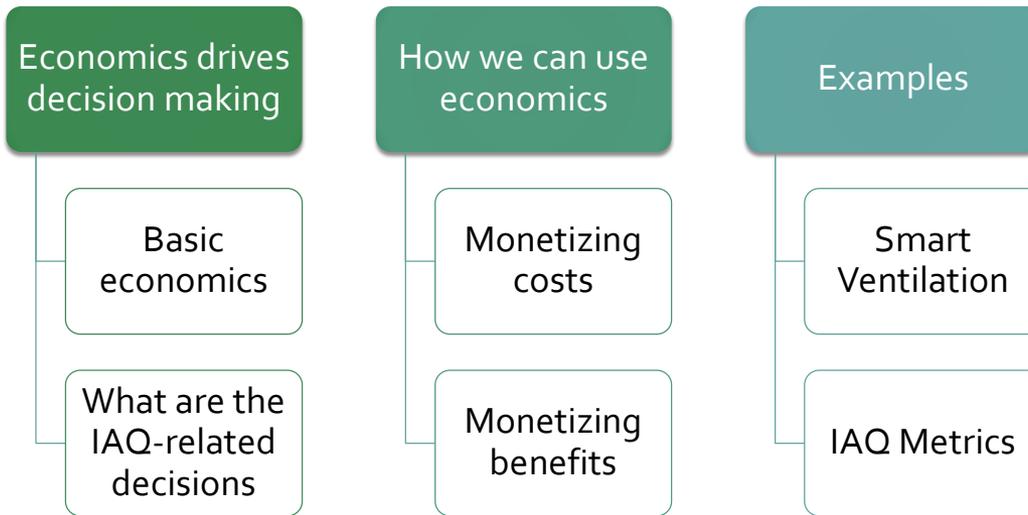
ECONOMICS OF IAQ

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Overview



Economics



...is the branch of knowledge concerned with the production, consumption and transfer of wealth.



Economic decision-making is the process of making decisions involving money.



Every IAQ decision involves money: some directly, some indirectly.

Economic Tools

Require identification of costs and benefits

- Usually separately identified as a function of time

Require *Monetization*

- All costs and benefits must be turned into a currency

Typical metrics

- Benefit-cost ratio
- Internal rate of return
- Payback time
- Net present value

Typical IAQ-related Decisions



Put in (and size)
ventilation and control
system



Use low-emitting
building materials and
appliances



Install air cleaning or
filtration



Meet a standard,
guideline or code

Factors in Decision



FIRST COST OF
CONSTRUCTION



ONGOING COST OF
OPERATIONS
(ENERGY)

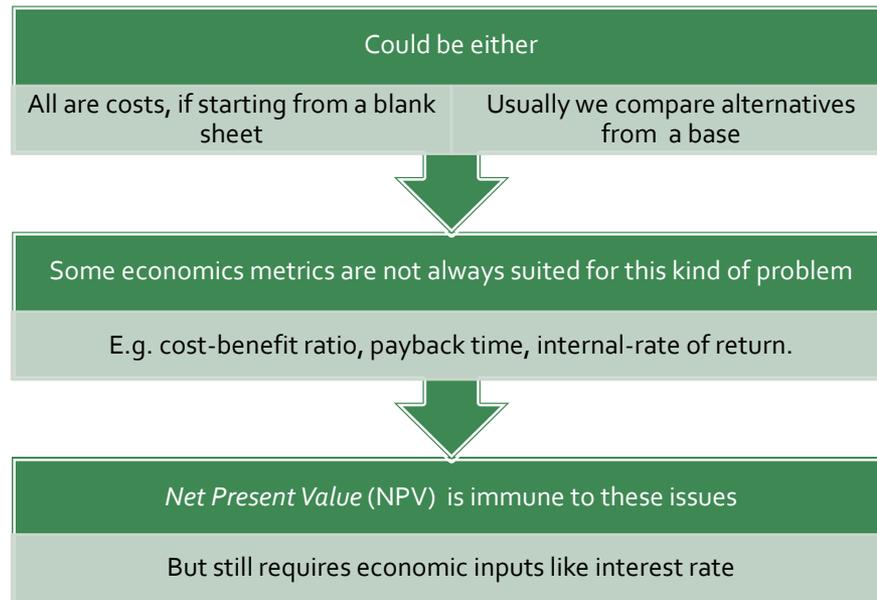


STAFF AND SUPPLY
MAINTENANCE COST



HEALTH AND
COMFORT IMPACT

Are those costs or benefits?



No

- No standard way to turn all IAQ factors into money

Maybe

- Standards can be used in some areas

Yes

- At least partially: We have ways monetize health

Key question:
Can we monetize IAQ?

How do standards help?

Replace monetization by minimum requirements

- Hopefully based on sound judgement
- ASHRAE Standard 62.2 is example of such a standard

Enable NPV-type calculation to optimize economic impact

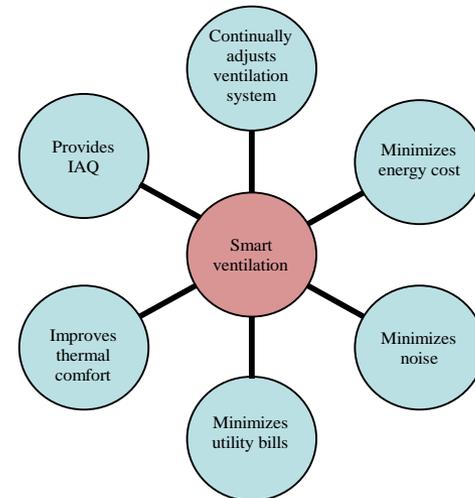
- All other costs and benefits are monetized
- Other economic metrics may work depending on details.

Allow innovative approaches

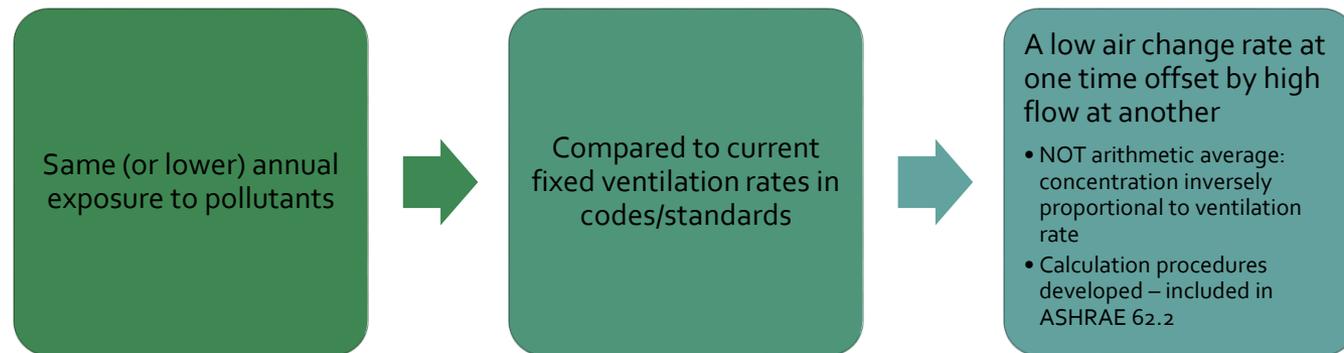
- If standards are flexible enough
- "Smart Ventilation" is key example.

What is Smart Ventilation?

- Shift ventilation in time and still provide acceptable IAQ
 - Ventilate more when conditions are favorable, less when conditions are extreme
- Use operation of other air moving/cleaning/humidity control devices to reduce ventilation requirements
- Smart systems can use this flexibility to
 - Reduce energy consumption
 - Respond to electric grid needs & rate structures
 - Respond to outdoor air quality excursions
 - Improve IAQ cheaply
 - Reduce peak loads



Maintaining IAQ - Equivalence



Smart Ventilation Example Approaches



Simple Timer

System off for worst 4 hours of the day. Same hours every day. Like a programmed thermostat



Sense weather

Use measured outdoor temperatures and humidity to control the ventilation system. Shift within a day, a week, a season



Sense other fans

Kitchen, bathroom & clothes dryer exhaust – include them in exposure calculation so ventilation fan can be turned off

Smart Ventilation Example Sensing



Respond to utility signal

System off/reduced at time of peak demand. Ventilate more later to “catch-up”



Respond to outdoor air quality

System off/reduced when outdoor air quality poor. Ventilate more later to “catch-up”



Respond to occupancy

Ventilate less when unoccupied
Keep track of pollutant build-up to avoid acute exposures

Smart Ventilation is Limited

Improves upon dumb ventilation, but...

- Is blind to harm done by contaminants
- Does allow for time-varying emission rates
- Does not allow economic trade-off

Must monetize IAQ directly to go further

- Need to move from hazards to harm and put all kinds of harms on equal footing...and then put a monetary value on that.

Move from "smart ventilation" to "smart IAQ"

- Transition to *IAQ Metrics*

Four aspects of IAQ quantified & monetized

Health

Comfort

Moisture

Occupant/Activities



Economics takes over to find optimal allocation of resources

Maximize Net Present Value

IAQ Metrics Vision

Disability Adjusted Life Years



Existing concept used in medical economics



Includes morbidity and mortality



i.e. shortening of life and loss of quality of life



Has had independent value, but varies

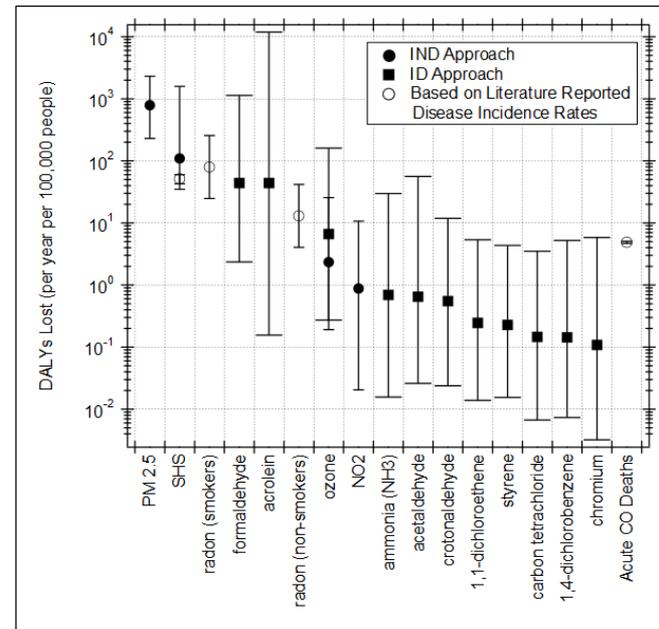
£100k pre-Brexit
€100k post-Brexit



Works for health, but not for others

DALYs Identify Contaminants of Concern

1. Particles
2. Products of combustion
3. Formaldehyde
- Radon/Ozone locally



SUMMING UP

IAQ is resistant to economic analysis.

The more we can monetize IAQ, the easier it will be to have it incorporated in everyday decision making.

IAQ Metrics is the ultimate approach for monetization, but it just in its infancy.

Smart Ventilation is an intermediate step that can be implemented today.

QUESTIONS

Thank You