SBE 2016, Tallinn - oktober 6, 2016

Wellbeing and productivity in sustainable buildings

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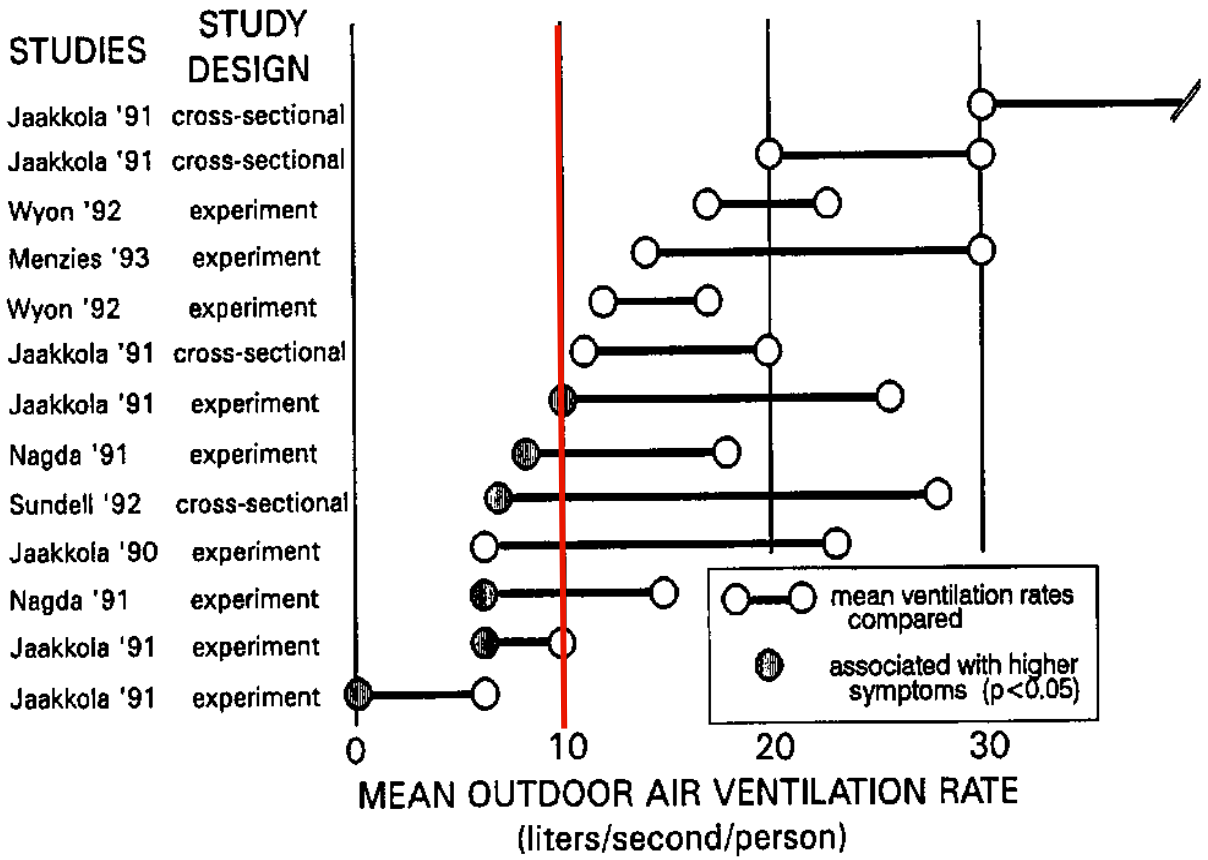
Wellbeing & sustainability

Wellbeing, health & comfort in buildings

Factors that influence wellbeing, health & comfort

THE SAME AS FOR ENERGY USE!

Indoor Environmental Quality matters!



fresh air supply < 10 L/s =
increased risk SBS symptoms!

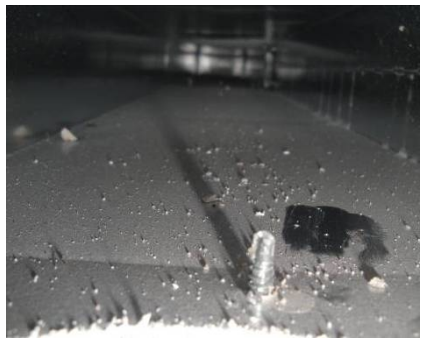
Source: Mendell et al (2000)

Too much focus on energy and investment costs, too little attention to wellbeing & health!

Overfocus on energy efficiency CAN have side-effects

NL study in 150 NEW dwellings with mechanical ventilation ventilation and heat recovery (Balvers, Boerstra, …, 2012):

- > 50% has insufficient overall air supply
- > 80% of bedrooms have installation noise levels > 30 dBA
- > 30% shortcircuiting at room level (see picture)
- > 20% overcomplicated, non-logic switches
- > 40% ductwork not properly installed (excess bending of ducts etc)
- > 50% no bypass on heat recovery unit



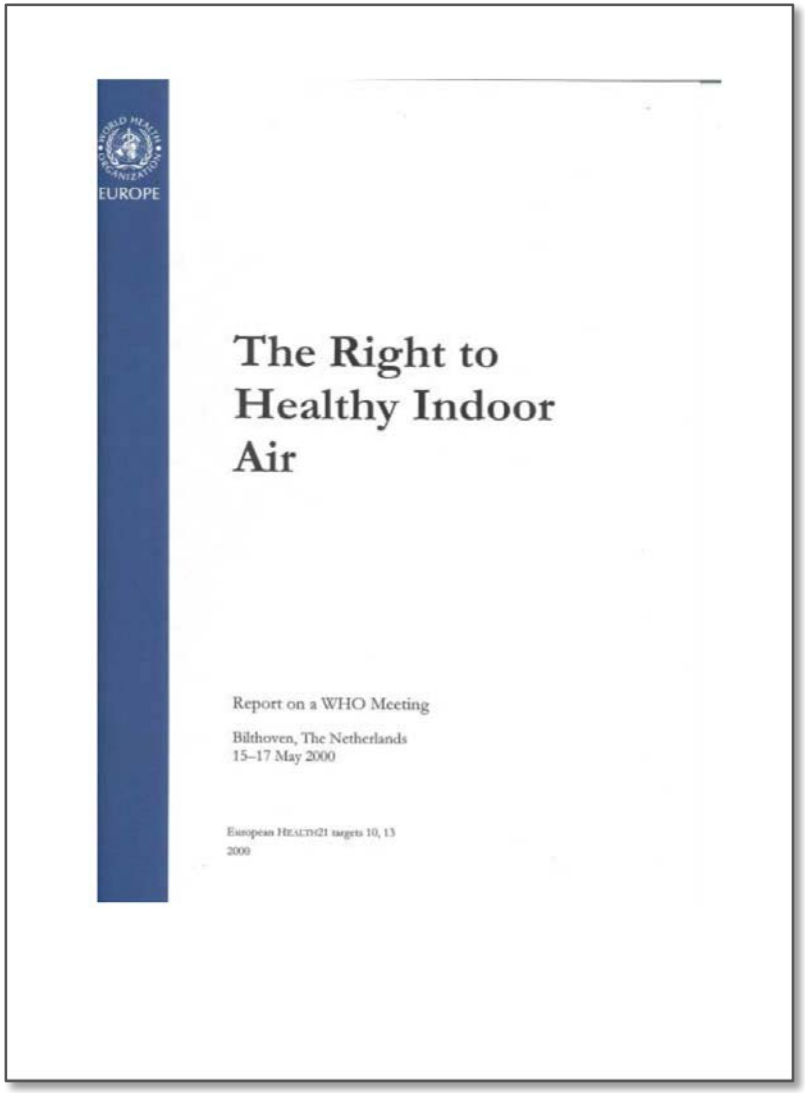
Sustainable = comfortable?!

Battle between man and machine?!

Intermezzo

World Health Organisation 2000:

“Building occupants have a right to healthy indoor air”

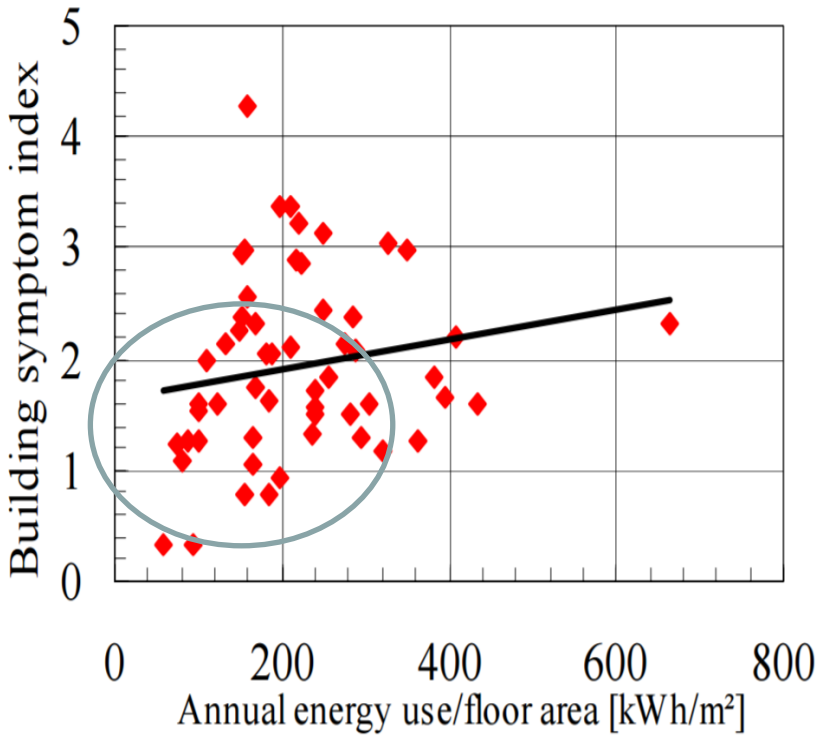


Sustainable = safe?!

IEQ crime scene, Meppel (NL), Christmas 2005

Sustainable = healthy?!

Sustainable AND healthy is just a matter of GOOD design!

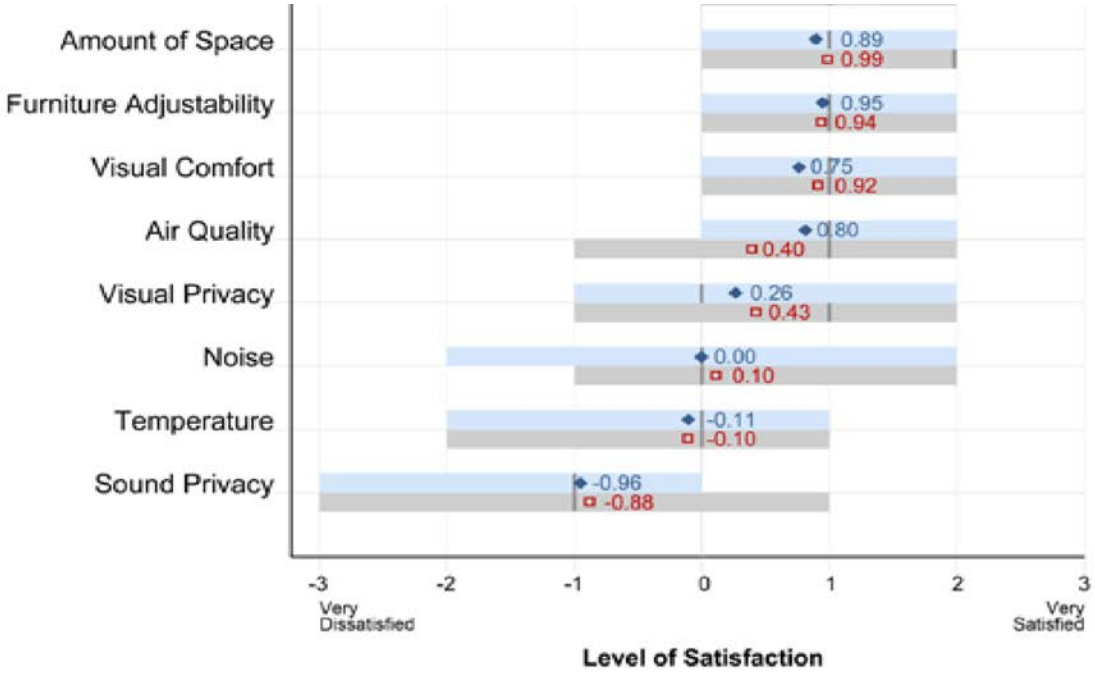


Source: EU HOPE study, Cox et al., 2001, see: www.hope.epfl.ch

Sustainable = happy?!

Centre of the Built Environment, UC Berkeley (Altomonte & Schiavon, 2013):

“Occupants of LEED buildings (BLUE) are (slightly) more satisfied with their indoor environment (e.g. air quality) than those in non-LEED buildings (RED)”



What decision makers think…

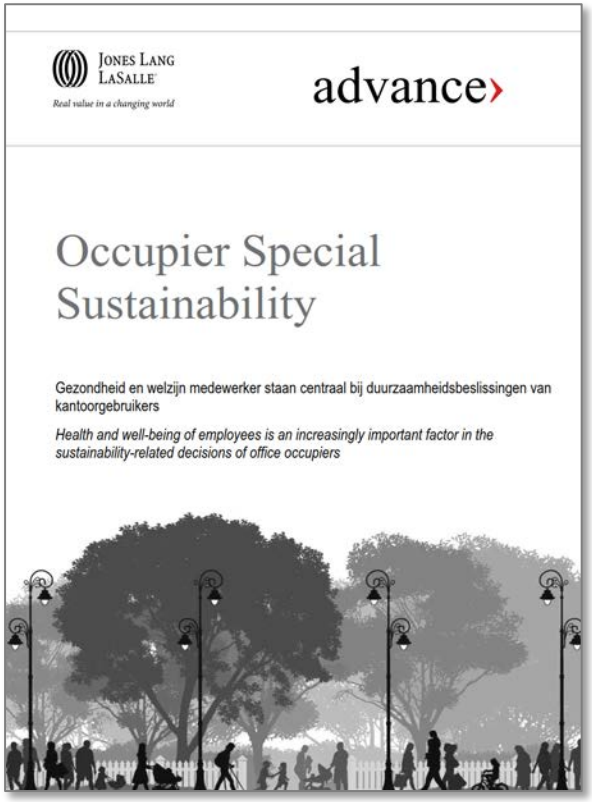
Jones Lang Lasalle report 2013:

"Health and wellbeing of employees is an increasingly important factor in sustainability-related decisions of office occupiers …"

Table 1: Importance sustainability categories

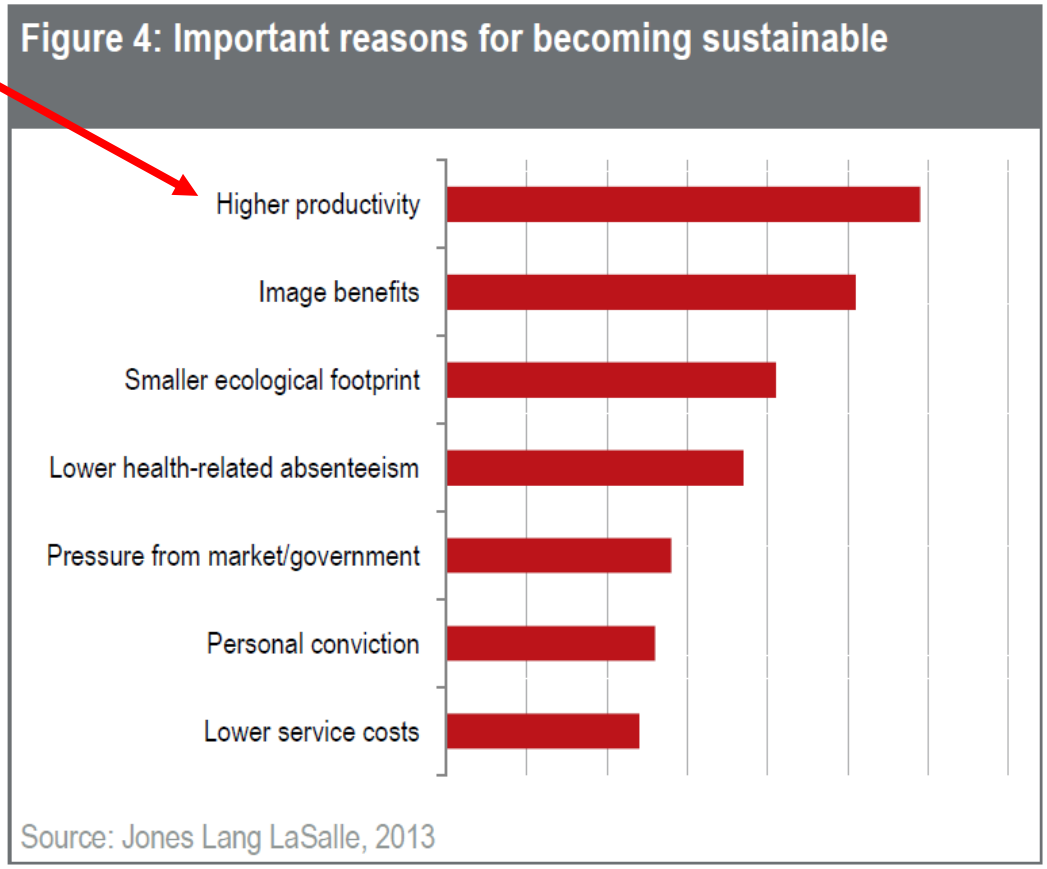
Position	2010	2013
1	Energy	Health and Well-being
2	Health and Well-being	Energy
3	Water	Transport
4	Material	Waste
5	Waste	Pollution
6	Pollution	Water
7	Transport	Materials
8	Management	Management
9	Land use and ecology	Land use and ecology

Source: Jones Lang LaSalle, 2013



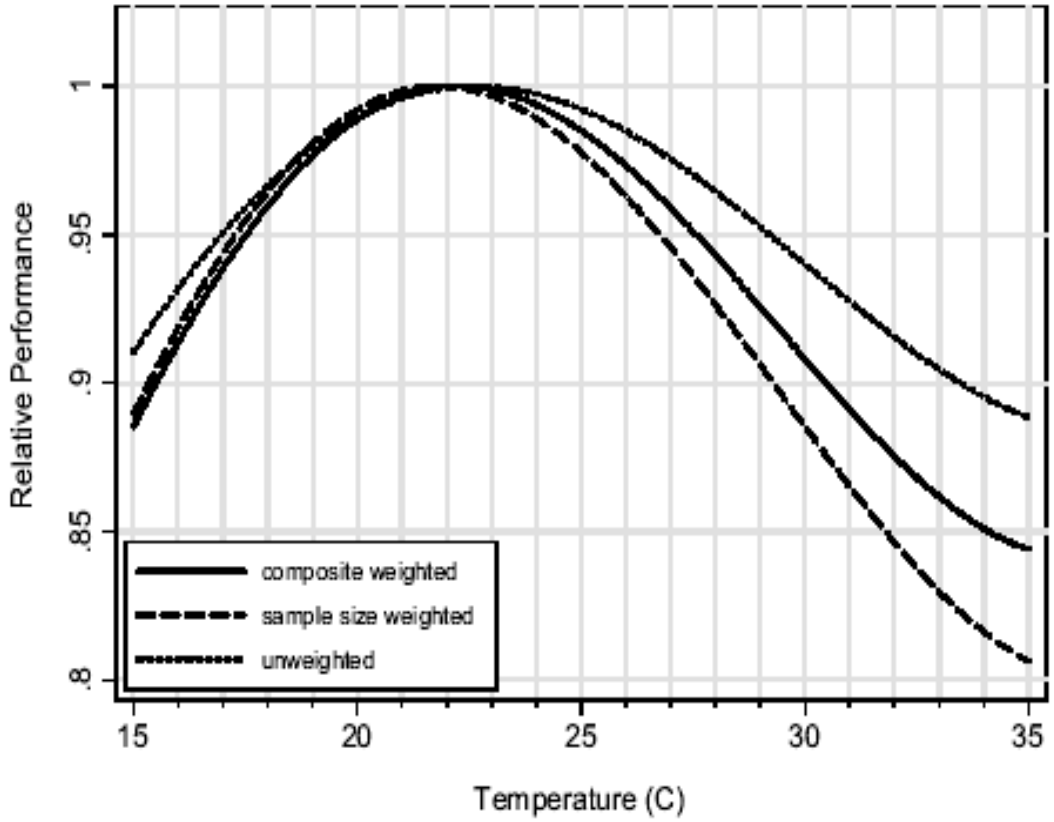
Productivity & sustainability

Jones Lang Lasalle report 2013



Effect of temperature on office work

Outside comfortzone performance drops with 2% per °C

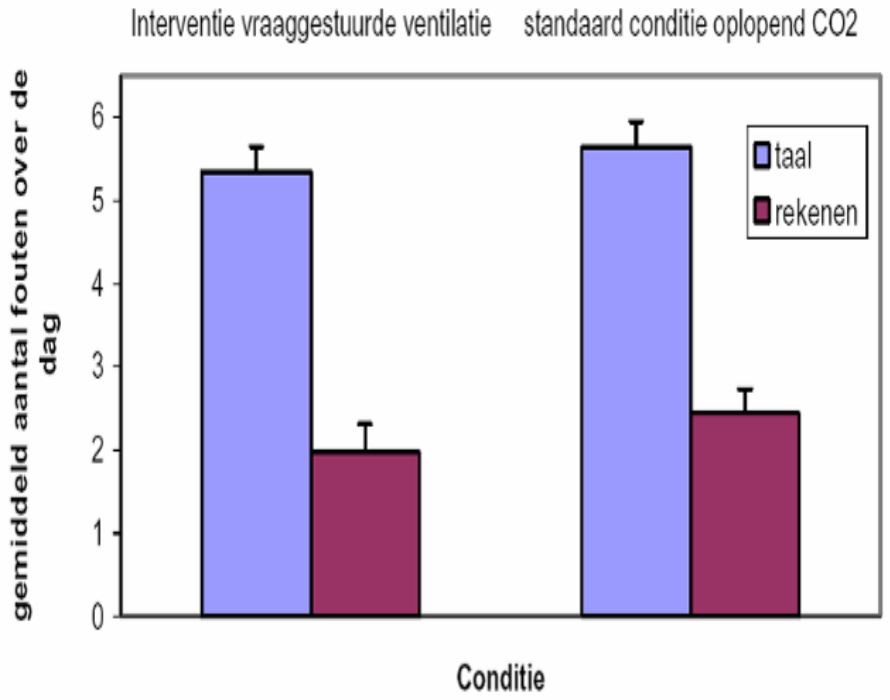


Source: REHVA guidebook 6, 2003

Effect of ventilation on learning performance

Study TNO (De Gids et al, 2006):

" With higer CO_2 concentrations in classrooms (around 1600 ppm) 6% more mistakes with language tests and 24% more mistakes with calculation tests; reference: demand controlled ventilation / CO_2 concentrations of ca. 800 ppm)"



Investing in school ventilation is investing in our children's future

General productivity effect various IEQ aspects

PAYBACK TIMES OFTEN < 1-2 YEARS!

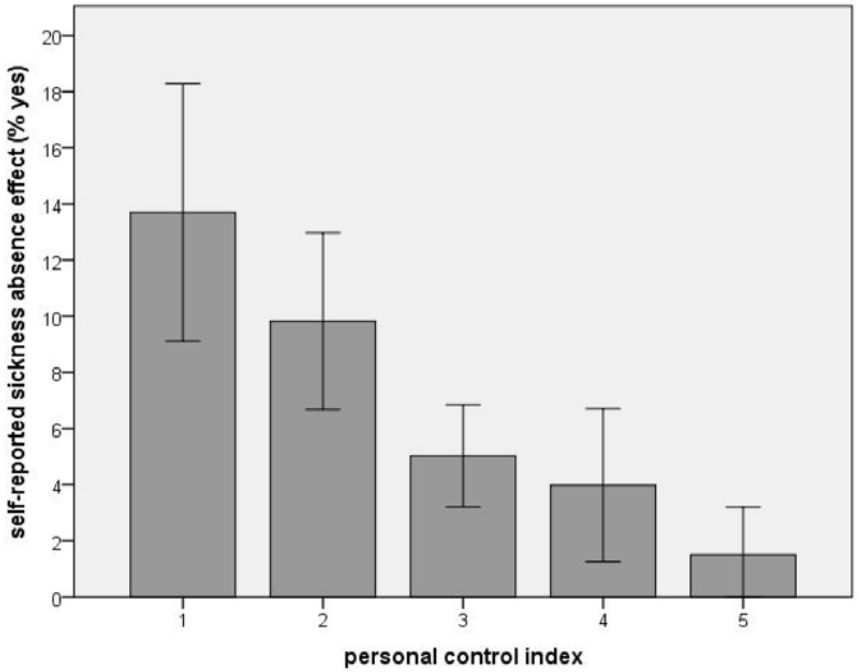
IEQ Aspect	Productivity effect
Thermal Environment	
Overheating summer	-2,5%
Low temperatures & draft winter	-2,5%
Temperature control	-4%
Indoor Air Quality	
Fresh air supply	-4%**
Excess pollution sources	-3%
Noise	
Acoustics / taling collegues	-7%
Installation / traffic noise	-2,5%
Light	
Lighting	-3%
Daylight / glare control	-5%

Source: Boerstra et al., 2014 / www.kantoorvolenergie.nl

Effect on sick leave

PhD study Boerstra, 2016:

“ Office workers with access to operable windows & adjustable thermostats (control index of 4 or 5) report significantly less sick leave days than those without controls.”



Investing in adequate controls helps to keep building occupants healthy (?)

What the World Green Building Council says

WGBC IEQ & productivity report 2014:

“There is overwhelming evidence that office design significantly impacts the health, wellbeing and productivity of staff”

The WELL building standard

General market development

McKinsey marketing research report 2012:

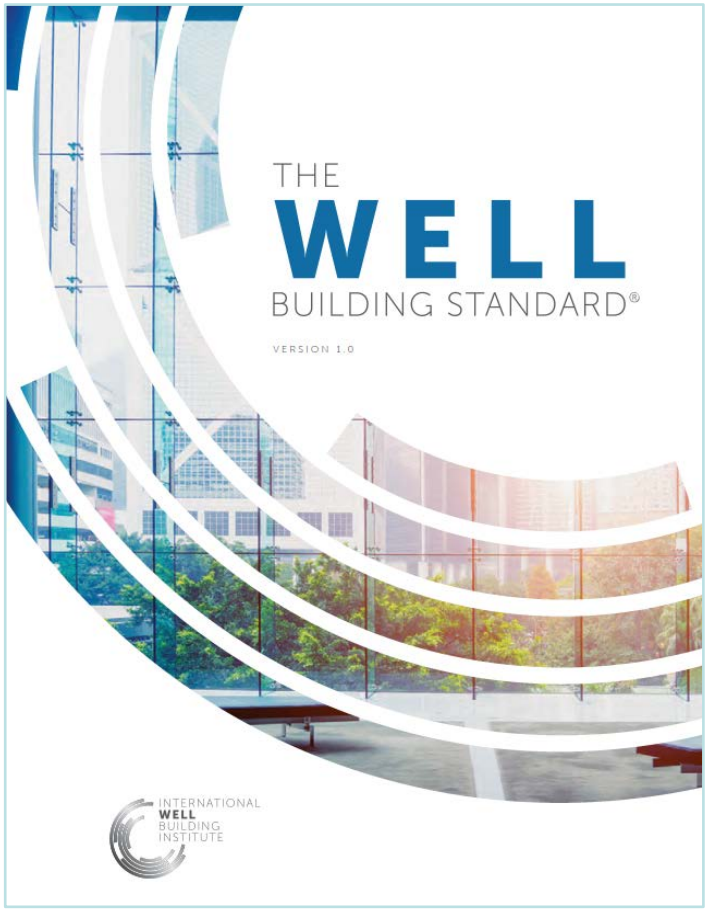
“The trends all point in a single direction: more and more CONSUMER SPENDING on health and wellness…”

“WELLNESS is the next TRILLION DOLLAR INDUSTRY as employers invest in healthy living programs and as customers take more responsibility for optimizing their own health.’’

BLUE IS THE NEW GREEN?!

The WELL building standard

- New standard for HEALTHY building
- Performance-based system that adresses impact of built environment on human health
- International (originally from US 2014)
  - IWBI (International WELL Building Institute)
  - GBCI (Green Building Certification Institute, LEED)
- For more info, see: www.wellcertified.com and www.bluebuildinginstitute.eu



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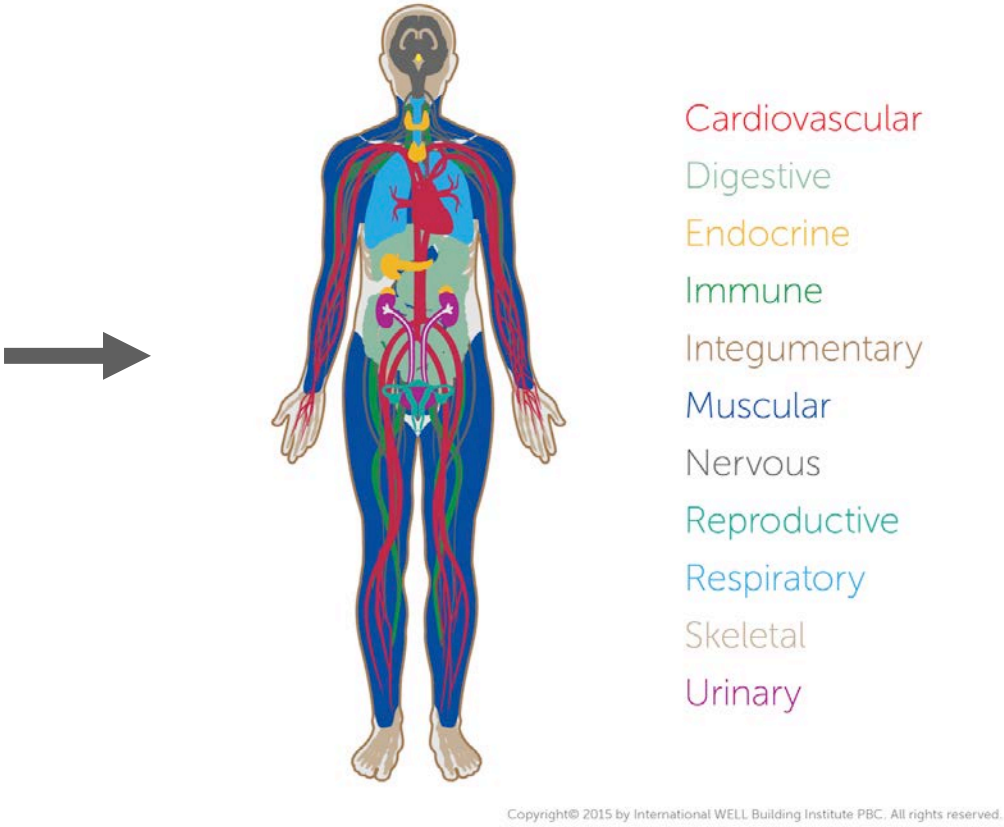
Cardiovascular
Digestive
Endocrine
Immune
Integumentary
Muscular
Nervous
Reproductive
Respiratory
Skeletal
Urinary
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3 levels of WELL certification

Nutrition label analogy

“WELL is like a nutrition label for your building, providing transparency on the quality of our built environment…”

01

AIR QUALITY STANDARDS

	Core and Shell	New and Existing Interiors	New and Existing Buildings
PART 1: STANDARDS FOR VOLATILE SUBSTANCES	P	P	P

The following conditions are met:

a.[1] Formaldehyde levels less than 27 ppb.

b.[1] Total volatile organic compounds less than 500 µg/m³.

PART 2: STANDARDS FOR PARTICULATE MATTER AND INORGANIC GASES	P	P	P

The following conditions are met:

a.[2] Carbon monoxide less than 9 ppm.

b.[2] $PM_{2.5}$ less than 15 µg/m³.

c.[3] PM_{10} less than 50 µg/m³.

d.[3] Ozone less than 51 ppb.

PART 3: RADON	P	P	P

The following conditions are met in projects with regularly occupied spaces at or below grade:

a.[4] Radon less than 4 pCi/L in the lowest occupied level of the project.

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INTERNALLY GENERATED NOISE

PART 1: ACOUSTIC PLANNING

-	P	P

An acoustic plan is developed that identifies the following:

a.[90] Loud and quiet zones.

b. Noisy equipment in the space.

PART 2: MECHANICAL EQUIPMENT SOUND LEVELS

O	P	P

The mechanical equipment system meets the following requirements once interior build-out is complete in the following spaces:

a.[90] Open office spaces and lobbies that are regularly occupied and/or contain workstations: maximum noise criteria (NC) of 40.

b.[90] Enclosed offices: maximum noise criteria (NC) of 35.

c. Conference rooms and breakout rooms: maximum noise criteria (NC) of 30 (25 recommended).

d.[90] Teleconference rooms: maximum noise criteria (NC) of 20.

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THERMAL COMFORT

	Core and Shell	New and Existing Interiors	New and Existing Buildings
PART 1: VENTILATED THERMAL ENVIRONMENT	P	P	P

All spaces in mechanically-ventilated projects meet the design, operating and performance criteria:

a.[92] ASHRAE Standard 55-2013 Section 5.3, Standard Comfort Zone Compliance.

PART 2: NATURAL THERMAL ADAPTATION	P	P	P

All spaces in naturally-ventilated projects meet the following criteria:

a.[92] ASHRAE Standard 55-2013 Section 5.4, Adaptive Comfort Model.

Or NEN-EN-ISO 7730 / EN 15251: min. B / Cat. II
(-0,5 < PMV > +0,5; temperature winter
20-24 °C, temperature summer 23-26 °C)

The FUTURE (?)

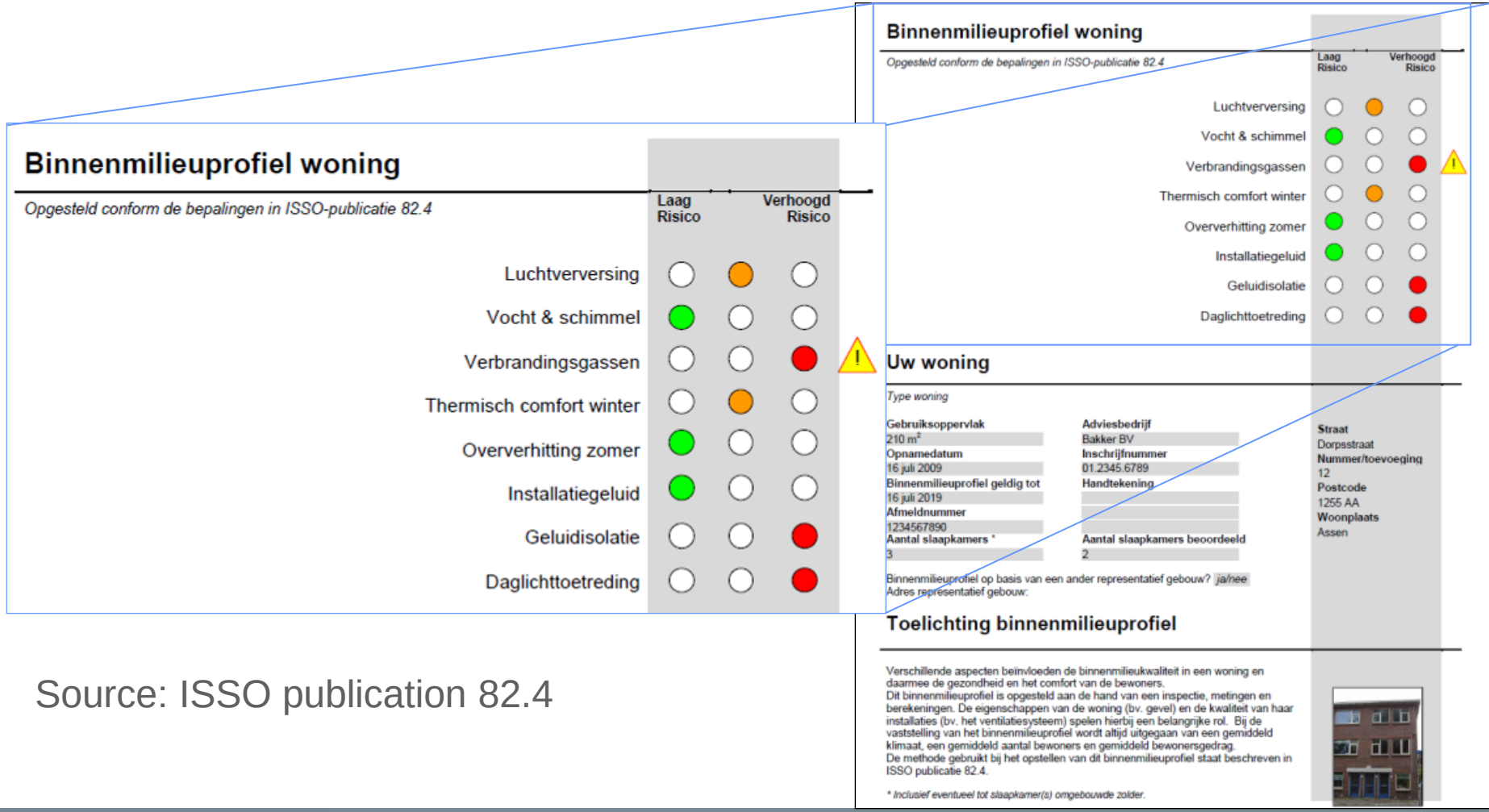
IEQ warning instruments

Aerometers (more info: www.fabianzeijler.com)

IEQ wearables

TZOA enviro-tracker (more info: www.tzoa.com)

Wellbeing / IEQ label as addition to energy label



Binnenmilieuprofiel woning

Opgesteld conform de bepalingen in ISSO-publicatie 82.4

	Laag Risico		Verhoogd Risico
Luchtverversing	○	●	○
Vocht & schimmel	●	○	○
Verbrandingsgassen	○	○	●
Thermisch comfort winter	○	●	○
Oververhitting zomer	●	○	○
Installatiegeluid	●	○	○
Geluidisolatie	○	○	●
Daglichttoetreding	○	○	●

Uw woning

Type woning

Gebruiksoppervlak	**Adviesbedrijf**
210 m²	Bakker BV
Opnamedatum	**Inschrijfnummer**
16 juli 2009	01.2345.6789
Binnenmilieuprofiel geldig tot	**Handtekening**
16 juli 2019	
Afmeldnummer	
1234567890	
Aantal slaapkamers *	**Aantal slaapkamers beoordeeld**
3	2

Straat Dorpsstraat
Nummer/toevoeging 12
Postcode 1255 AA
Woonplaats Assen

Binnenmilieuprofiel op basis van een ander representatief gebouw? ja/nee
Adres representatief gebouw:

Toelichting binnenmilieuprofiel

Verschillende aspecten beïnvloeden de binnenmilieukwaliteit in een woning en daarmee de gezondheid en het comfort van de bewoners.
Dit binnenmilieuprofiel is opgesteld aan de hand van een inspectie, metingen en berekeningen. De eigenschappen van de woning (bv. gevel) en de kwaliteit van haar installaties (bv. het ventilatiesysteem) spelen hierbij een belangrijke rol. Bij de vaststelling van het binnenmilieuprofiel wordt altijd uitgegaan van een gemiddeld klimaat, een gemiddeld aantal bewoners en gemiddeld bewonersgedrag.
De methode gebruikt bij het opstellen van dit binnenmilieuprofiel staat beschreven in ISSO publicatie 82.4.

** Inclusief eventueel tot slaapkamer(s) omgebouwde zolder.*

Source: ISSO publication 82.4

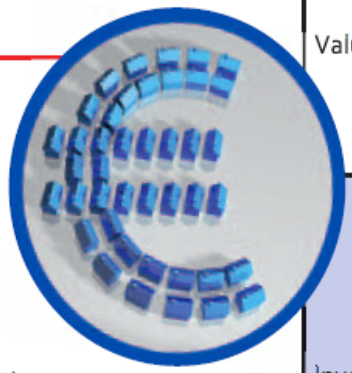
Wellbeing / IEQ performance as value case

Asset value

"Good indoor environment and energy efficient building proofed by LEED Platinum certificate can increase property value by over 8%."

Valuing Green Building Certificates as Real Options

[Vimpari & Junnila 2013]



In the study, it is argued that green certificates can be valued as real options by identifying the option characteristics of green certificates. A mean real option value of 985,000 € (or 8.8% premium to the mean property value) was found for a LEED Platinum certificate in the Finnish property market.

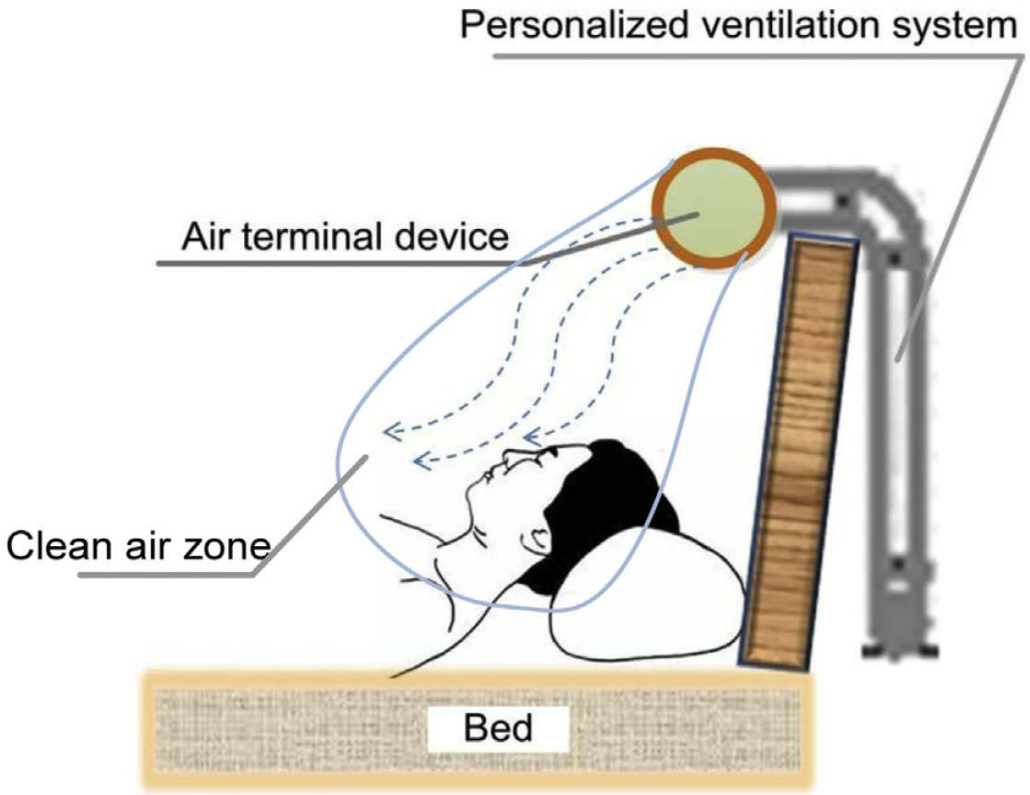
Results from 10-year DCF

Group	Valuer	Scenario	Potential Gain (1000 €)
Valuers	V1	High Gain	390
		Best (a)	390
		Low Gain	270
	V2	High Gain	1 160
		Best (a)	990
		Low Gain	810
Investors	I1	High Gain	2 950
		Best (a)	2 800
		Low Gain	2 750
	I2	High Gain	960
		Best (a)	190
		Low Gain	150
	I3	High Gain	850
		Best (a)	840
		Low Gain	760

Microclimatisation solutions @ work

JEP system *(Source: www.vandelftgroep.com)*

Microclimatisation solutions @ home



Source: Lan et al., 2013

Conclusions

- Wellbeing, comfort & health matters (matters too)
- Productivity effects of good indoor environment are substantial
- Overfocus on energy performance can be risky
- Energy efficient AND healthy building should go hand-in-hand
- WELL building standard could help to put wellbeing on the agenda (again)

- BLUE is the new GREEN