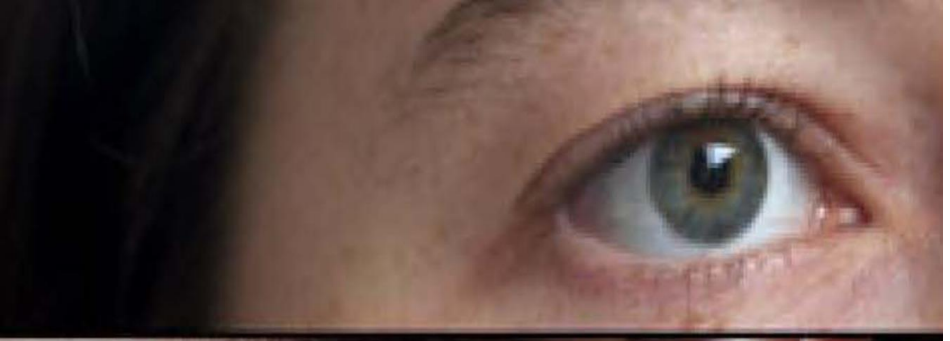
FLAGSHIP
COOL AND CLEAN BUILDINGS

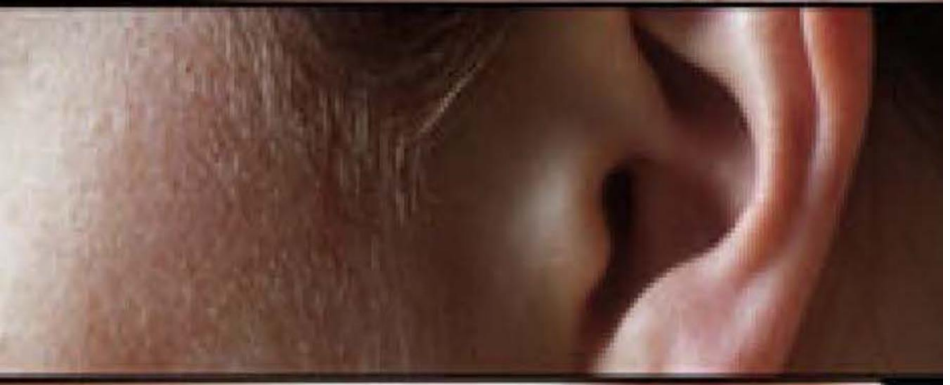
AnneMarie Eijkelenboom, PhD MSc

Faculty of Architecture
and the Built Environment

LUNCH LECTURE

11 APRIL 2024





Wikimedia The weather project, Olafur Elliasson

Buildings










Image 1 DKV architects, other images EGM Architects

People in buildings

Image 1 DKV architects, other images EGM Architects

How much of their time do people stay indoors in urban areas?

70% ?

80% ?

90% ?

World Health Organisation (WHO), Air Quality Guidelines for Europe, Second Edition, Regional Publications, European Series No. 91, Copenhagen, 2000.

Research field of indoor environmental quality

Focus on interactions of

visual, acoustic, indoor air, and thermal parameters

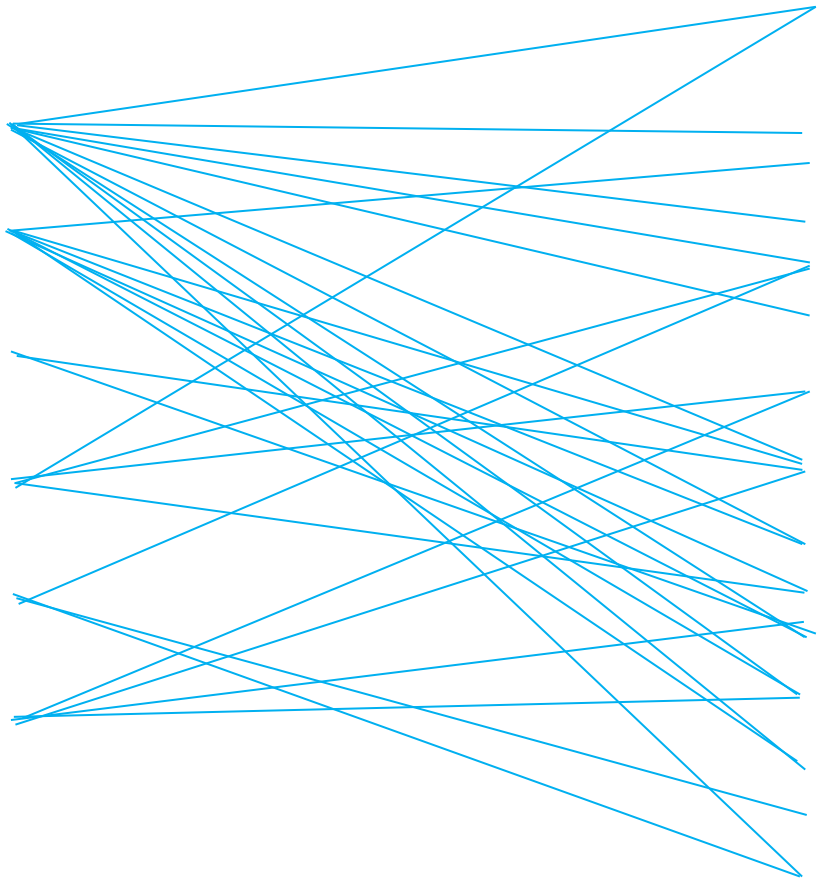
that affect health and comfort of occupants

in buildings.

images EGM Architects

Empirical research (only in hospitals)

Visual
Acoustic
Thermal
Indoor air
Layout
Overall



Duration of stay
Pain medication
Hospitalisation
Medication errors
Mortality
Delirium
Infection
Stress
Sleep quality
Building related symptoms
Comfort
Satisfaction with work or care
Work strain
Privacy
Mood

Eijkelenboom, A. and P. M. Bluyssen (2022). "Comfort and health of patients and staff, related to the physical environment of different departments in hospitals: a literature review." *Intelligent Buildings International* **14**(1): 95-113.

Healthy indoor conditions and climate change

nature medicine

Explore content | About the journal | Publish with us

nature > nature medicine > articles > article

Article | Open access | Published: 10 July 2023

Heat-related mortality in Europe during the summer of 2022

Joan Ballester, Marcos Quijal-Zamorano, Raúl Fernando Méndez Turrubiates, Ferran Pegenaute, François R. Herrmann, Jean Marie Robine, Xavier Basagaña, Cathryn Tonne, Josep M. Antó & Hicham Achebak

Nature Me

105k Acc

An

This

Abstra

Over 70,0
societal a
at-risk po
of 2022, t
which inc

World Health Organization | Health Topics | Countries | Newsroom | Emergencies

166 000 people died

More than 166 000 people died due to extreme temperatures between 1998-2017

Find out more

NOS | Nieuws | Sport | Live | Programma's

NOS Nieuws • Maandag 10 juli 2023, 19:26 •
Aangepast maandag 10 juli 2023, 20:04

61.000 hittedoden in Europa door de hete zomer van 2022

Healthy indoor conditions and climate change

nature medicine

Explore content | About the journal | Publish with us

nature > nature medicine > articles > article

Article | Open access | Published: 10 July 2023

Heat-related mortality in Europe during the summer of 2022

Joan Ballester, Marcos Quijal-Zamorano, Raúl Fernando Méndez Turrubiates, Ferran Pegenaute, François R. Herrmann, Jean Marie Robine, Xavier Basagaña, Cathryn Tonne, Josep M. Antó & Hicham Achebak

Nature Me

105k Acc

An

This

Abstra

Over 70,0
societal a
at-risk po
of 2022, t
which inc

World Health Organization | Health Topics | Countries | Newsroom | Emerg

166 000 people died

More than 166 000 people died due to extreme temperatures between 1998-2017

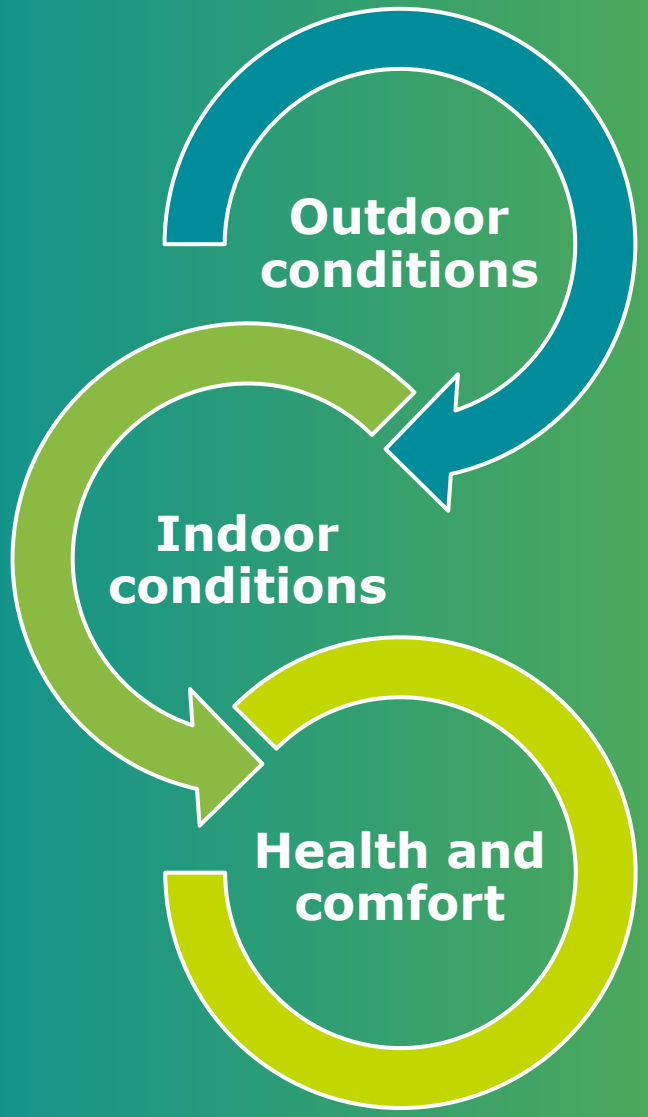
Find out more

NOS | Nieuws | Sport | Live | Programma's

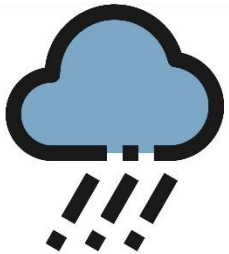
NOS Nieuws • Maandag 10 juli 2023, 19:26 •
Aangepast maandag 10 juli 2023, 20:04

61.000 hittedoden in Europa door de hete zomer van 2022

Changing outdoor conditions



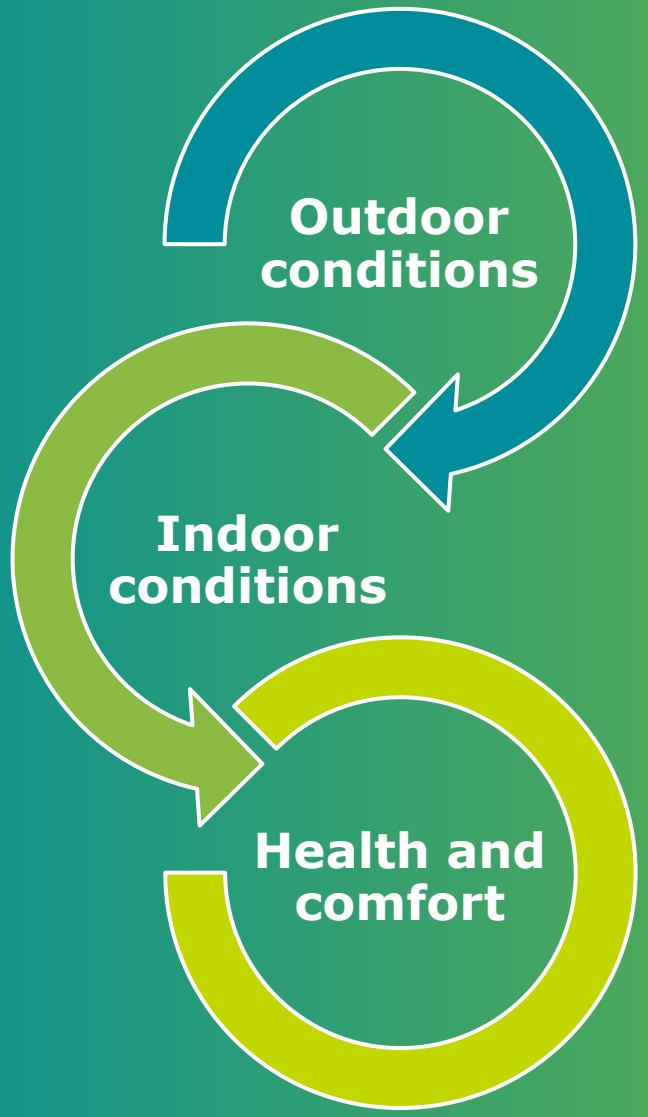
- Rising outdoor temperature
- Intensified heatwaves

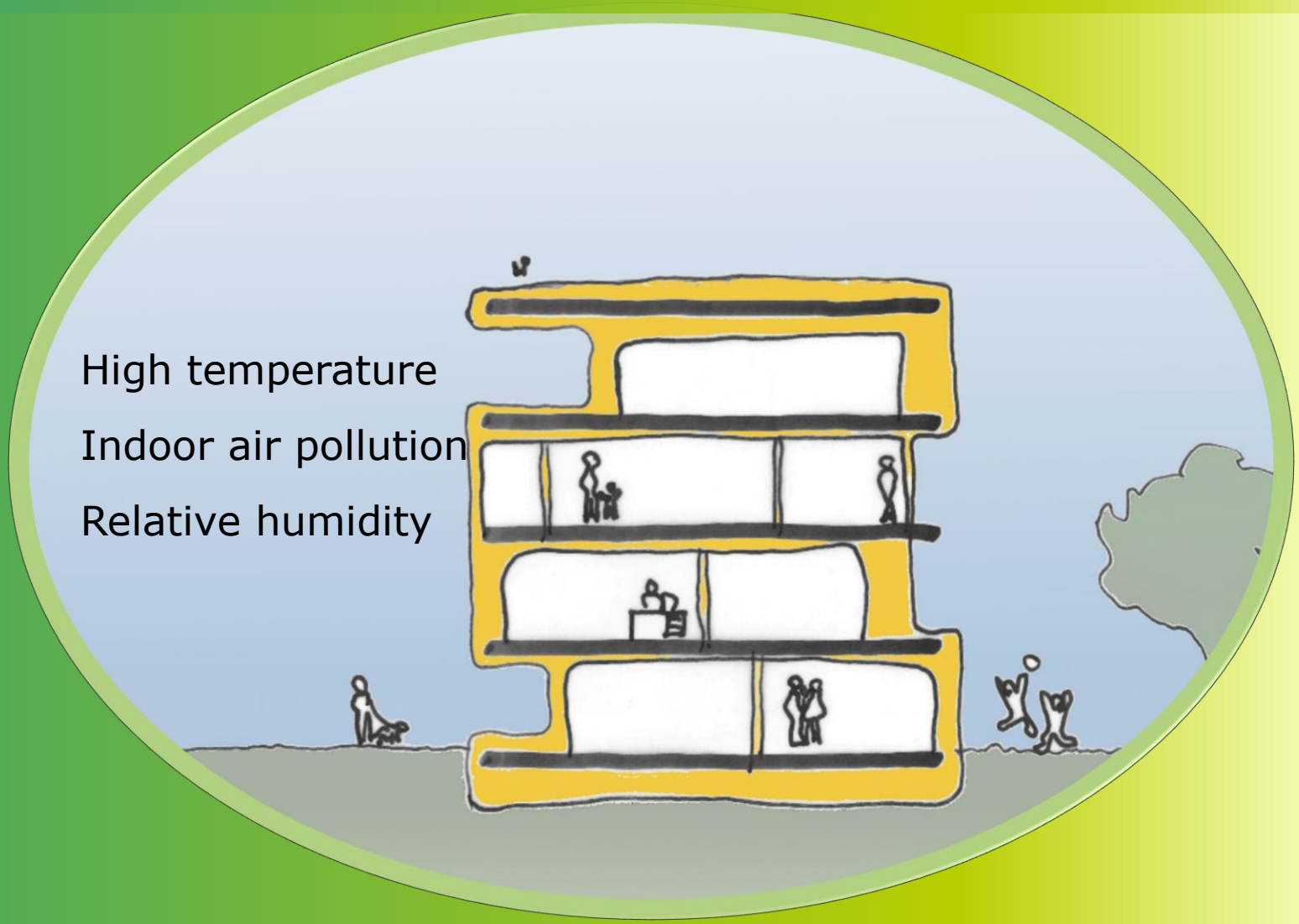


- Intensified rainfall

- Increased air pollution

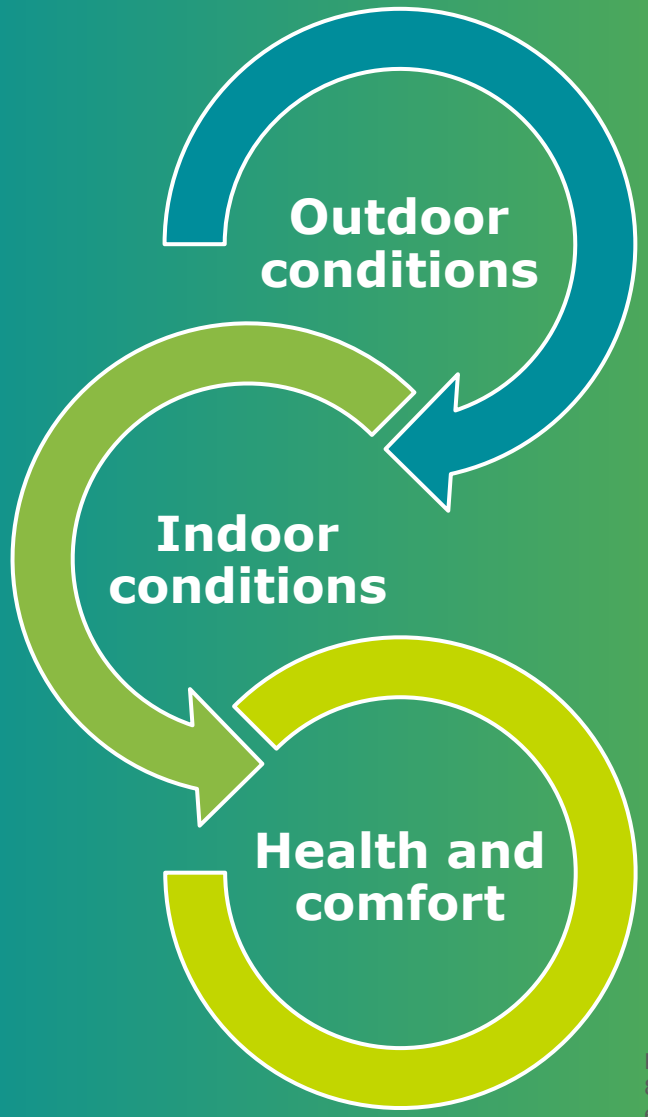
Changing indoor conditions

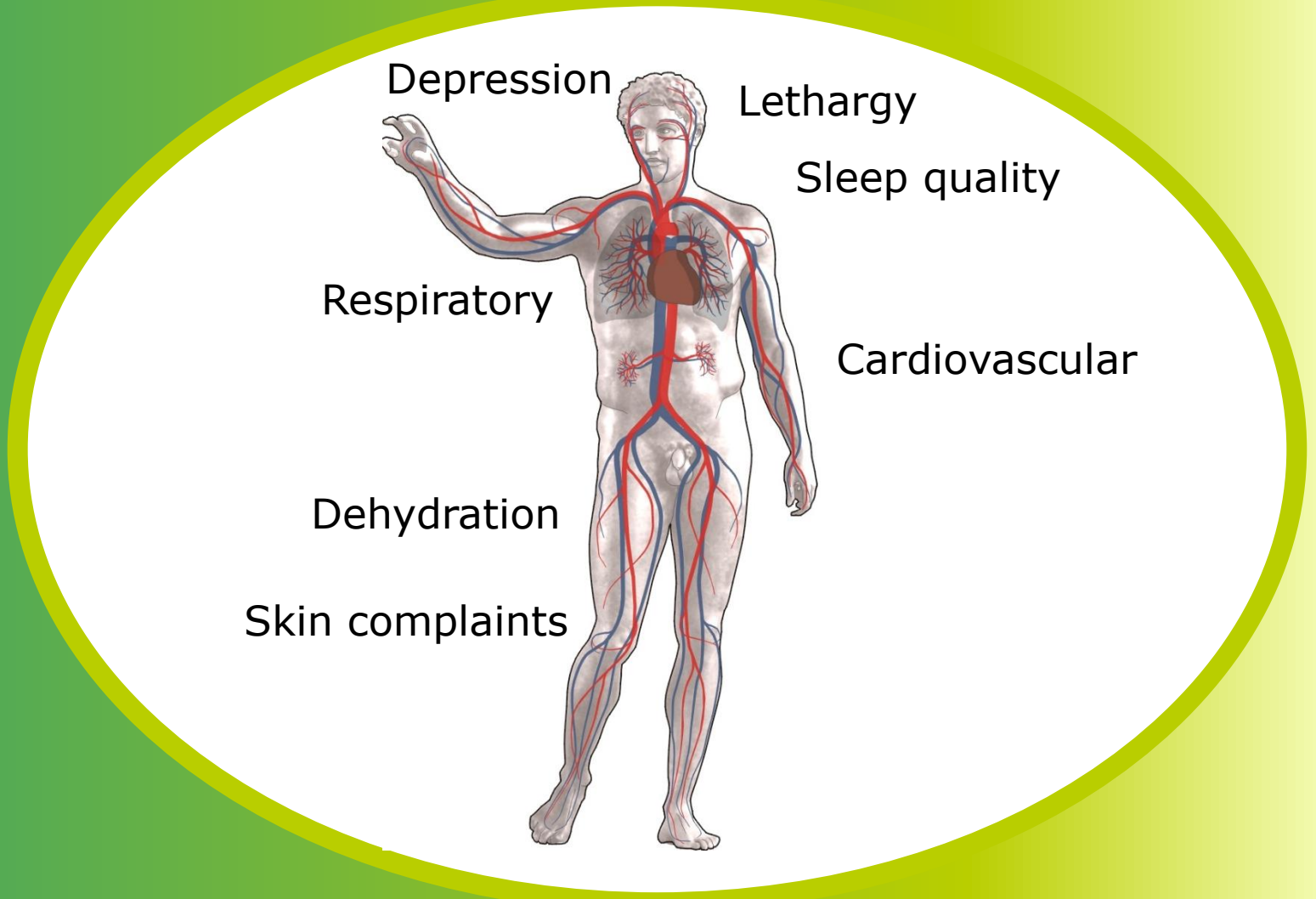




Ortiz, M., et al. (2020). "Indoor environmental quality related risk factors with energy -efficient retrofitting of housing: A literature review." *Energy and Buildings* **221**.

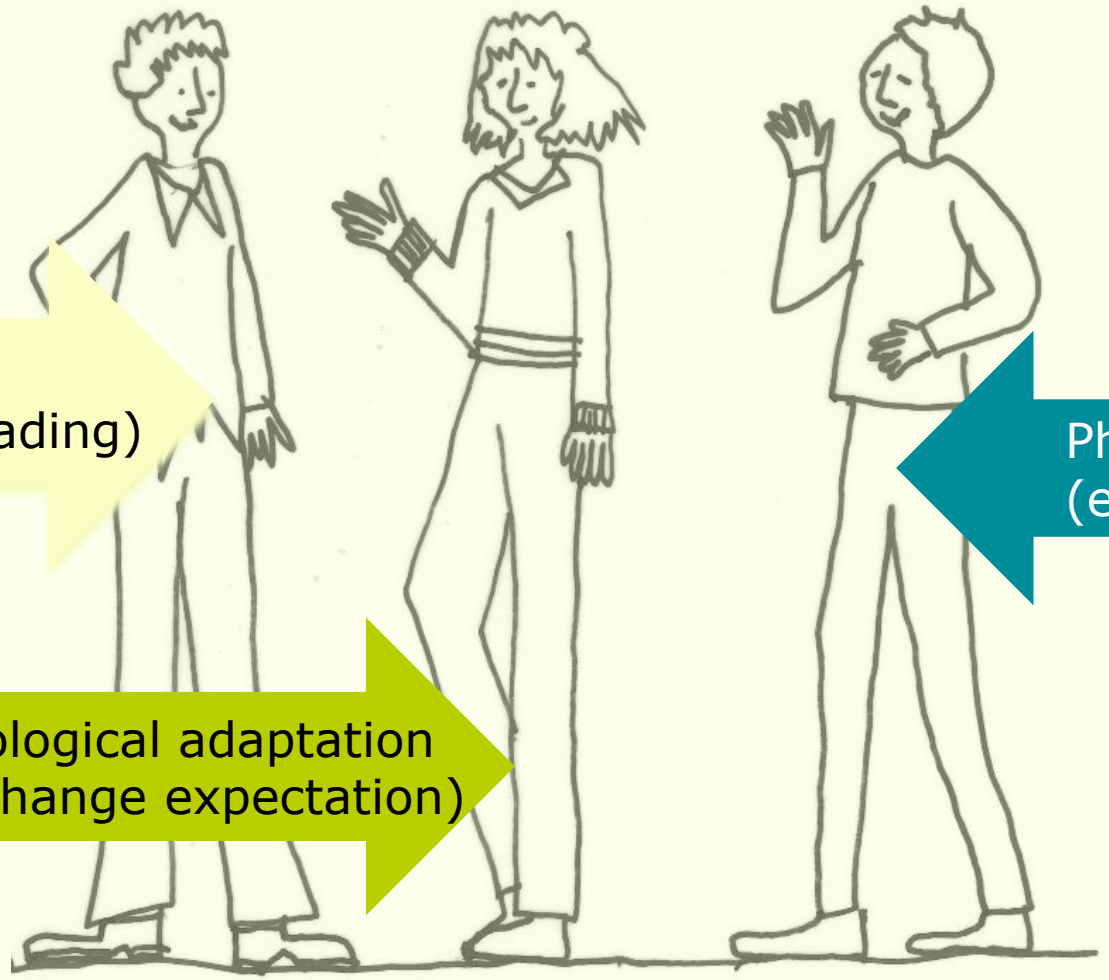
Health risks





Khraishah, H., et al. (2022). "Climate change and cardiovascular disease: implications for global health." *Nature Reviews Cardiology* **19**(12): 798-812. Ballester, J., et al. (2023). "Heat-related mortality in Europe during the summer of 2022." *Nature Medicine* **29**(7): 1857-1866. De Sario, M., et al. (2013). "Climate change, extreme weather events, air pollution and respiratory health in Europe." *European Respiratory Journal* **42**(3): 826-843.

Types of adaptive behaviour of occupants



Behavioural adaptation
(e.g. turn down solar shading)

Physiological adaptation
(e.g. acclimatization)

Psychological adaptation
(e.g. change expectation)

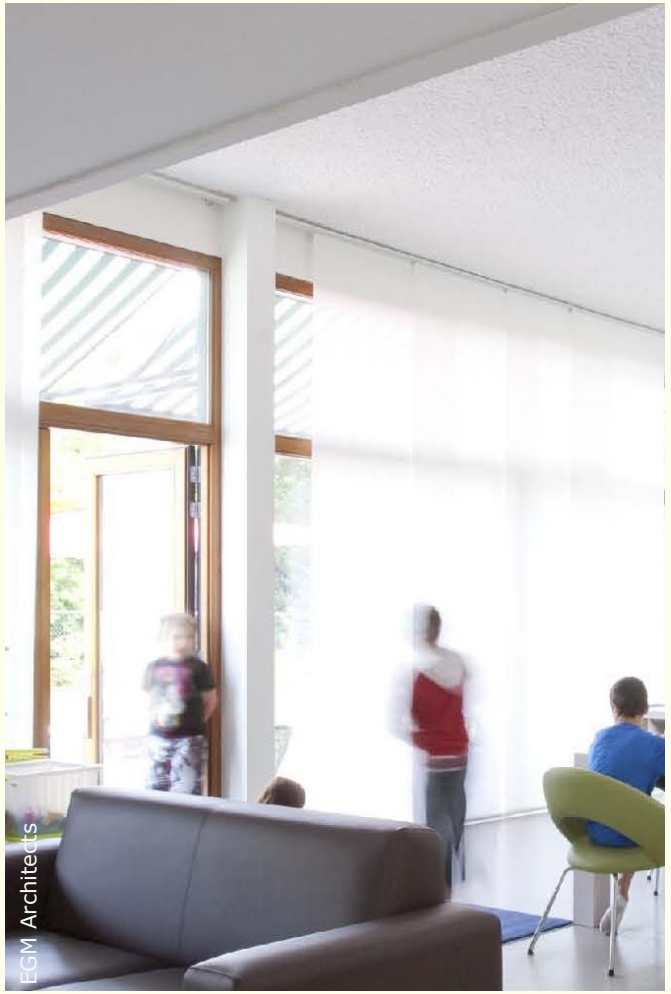
De Dear, R. J., et al. (1998). "Developing an adaptive model of thermal comfort and preference/discussion." *ASHRAE transactions* **104**: 145.Shin, J. (2016). Toward a theory of environmental satisfaction and human comfort: A process-oriented and contextually sensitive theoretical framework. *Journal of Environmental Psychology*, *45*, 11-21.

Adaptive behaviour

Overheating in homes varies due to occupant behaviour.

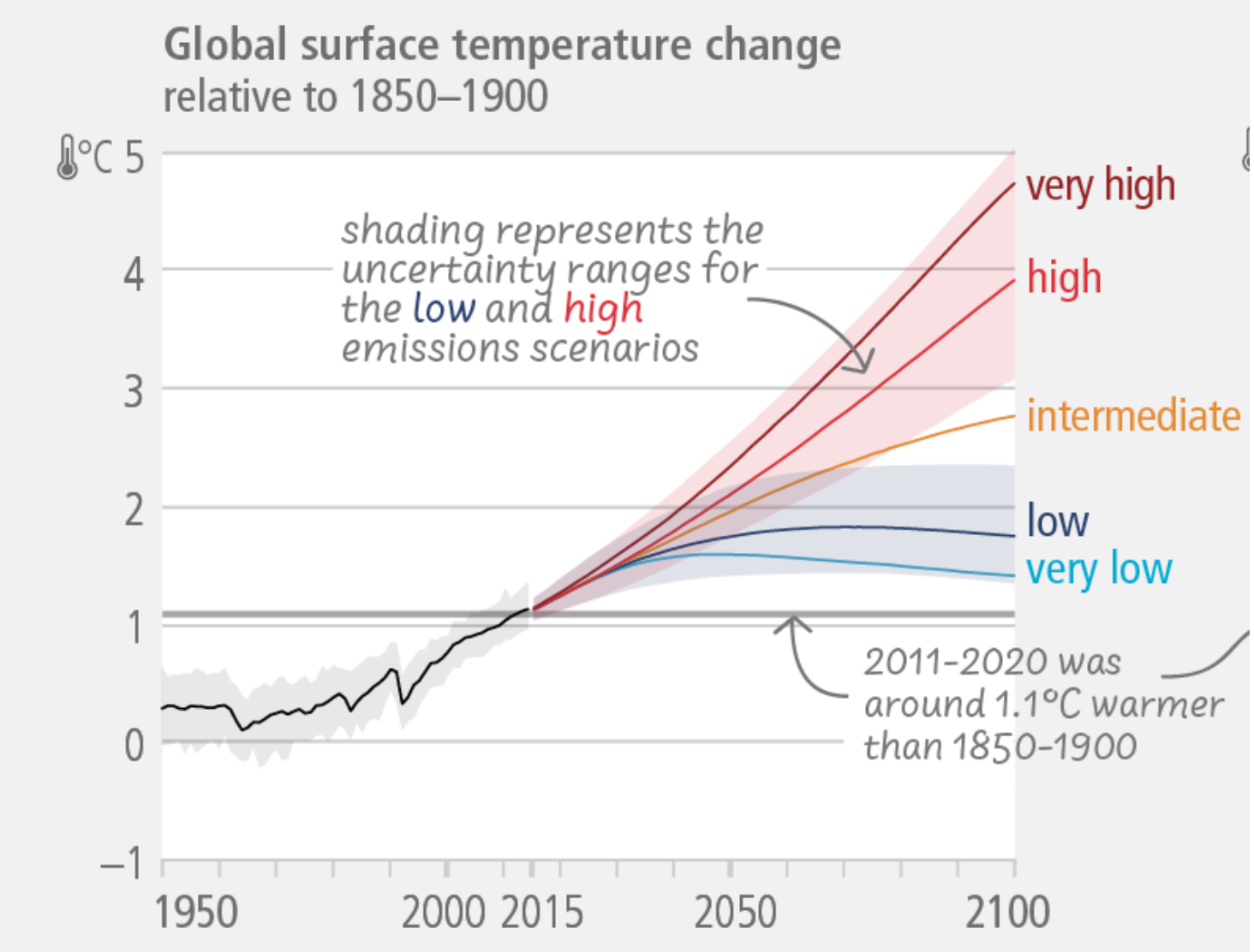
Adaptive behaviour changes because of climate change.

Adaptive behaviour does not necessarily affect health positively.



Altomonte, S., et al. (2020). "Ten questions concerning well-being in the built environment." *Building and Environment* **180**: 106949. Morgan, C., Foster, J. A., Poston, A., & Sharpe, T. R. (2017). Overheating in Scotland: contributing factors in occupied homes. *Building Research & Information*, *45*(1-2), 143-156. https://doi.org/10.1080/09613218.2017.1241472. Thomson, H., Simcock, N., Bouzarovski, S., & Petrova, S. (2019). Energy poverty and indoor cooling: An overlooked issue in Europe. *Energy and Buildings*, *196*, 21-29.

Uncertainties in climate change



IPCC (2023). Climate change 2023 Synthesis Report Summary for Policymakers, Intergovernmental Panel of Climate Change.

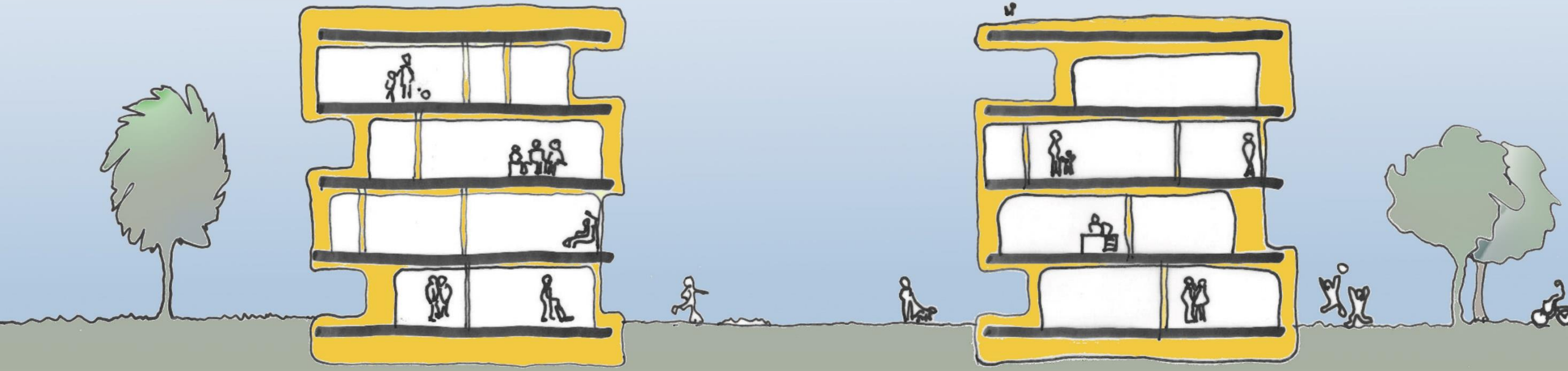
Adaptable buildings

Long term

- Changing outdoor conditions
- Changing occupants' needs
- New technology

Temporary

- Heatwaves
- Heavy rainfall



Example of adaptable buildings – Wallisblok, Rotterdam

Long term - construction (1930s)

New technology- CO2 and humidity sensor for control of ventilation (2021)

PV (2024?)

Long term – new façade (2005)

Temporary adaptability- seasonal placing of table (yearly)

Outdoors, communal garden (2005)

Image 1 from Architectuur in Nederland, Jaarboek 2007/2008, NAI Uitgevers, ISBN 978-90-5662-050-9. other images A. Eijkelenboom

Cool and clean buildings

Research required to develop insight into interactions of

changing behaviour of occupants,

adaptability of buildings,

and

new technology.

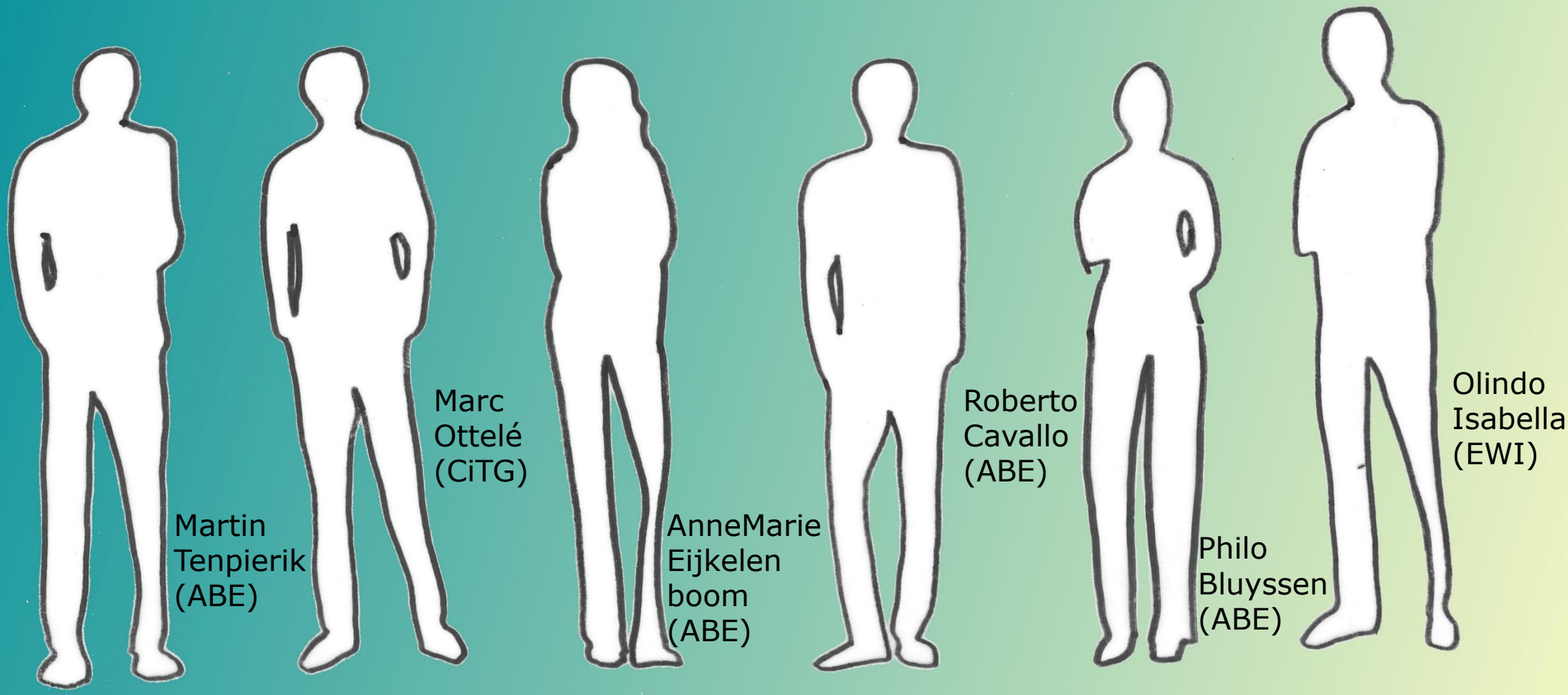
Research questions

1. Which combinations of building characteristics enable long term and temporary adaptation to support comfort and health in relation to outdoor heat and outdoor/indoor air pollution?

2. How is health associated with occupants' adaptation strategies to cope with indoor heat and air pollution?

3. Which new technologies contribute to energy neutral/positive buildings and protect occupants against indoor air pollution and heat?

Team Flagship



In short

Changing outdoor conditions (e.g., heatwaves) affect health and comfort of occupants while they are indoors.

Occupant behaviour, that differs among individuals and changes, affects health, comfort, and indoor conditions.

Long term adaptability of buildings is required due to uncertainties of predictions of climate change, changing behaviour, new building technology.

Building technology

Different occupants

Building adaptability

A healthy, comfortable spring!

Dr. ir. AnneMarie Eijkelenboom

a.m.eijkelenboom@tudelft.nl