



**TAL
TECH**

CENTRE OF RURAL ARCHITECTURE | 17.04.2024

ESTONIAN PERSPECTIVE TO VENTILATION SOLUTIONS IN BUILDING RENOVATION

Ülar Palmiste

nZEB Research Group

Tallinn University of Technology

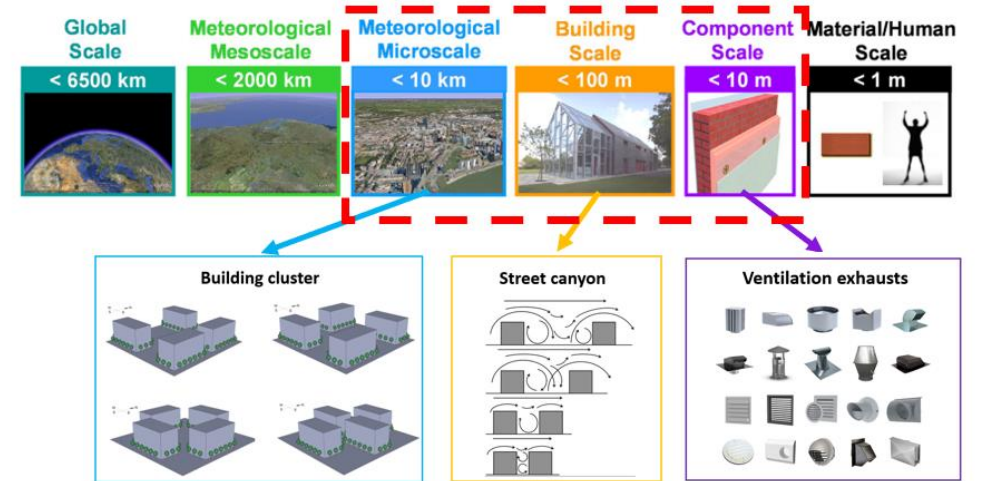
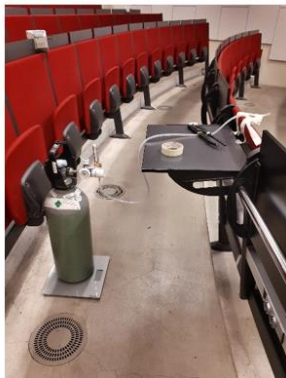
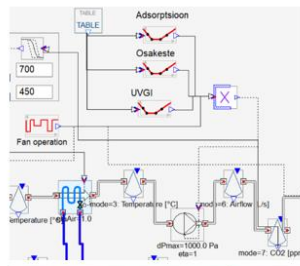
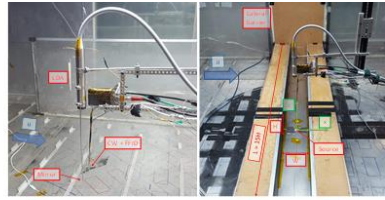
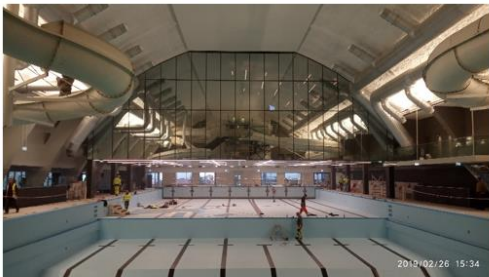
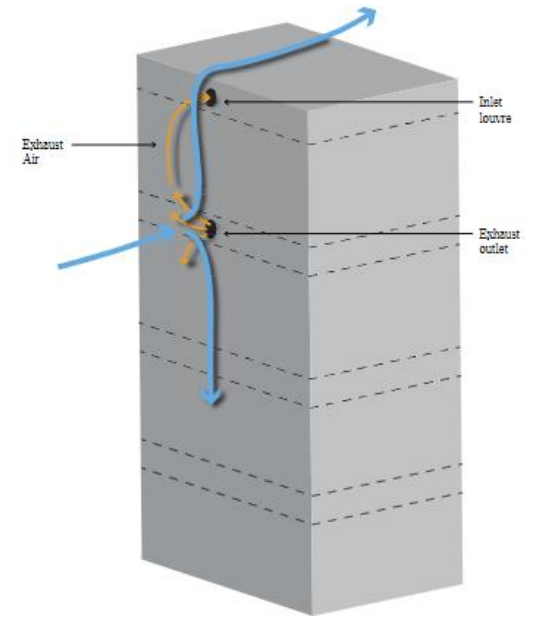
SHORT RESUME

Ülar Palmiste

- Doctoral student at Tallinn University of Technology
- Research topic: Pollutant dispersion around buildings
- HVAC design engineer at Termopilt OÜ

Scientific interests

- Airflows around buildings
- Indoor air quality



PRESENTATION OUTLINE

- Introduction
- Why ventilate?
- Overview of ventilation types
- Ventilation solutions in building renovation - Estonian perspective
- Some examples and references





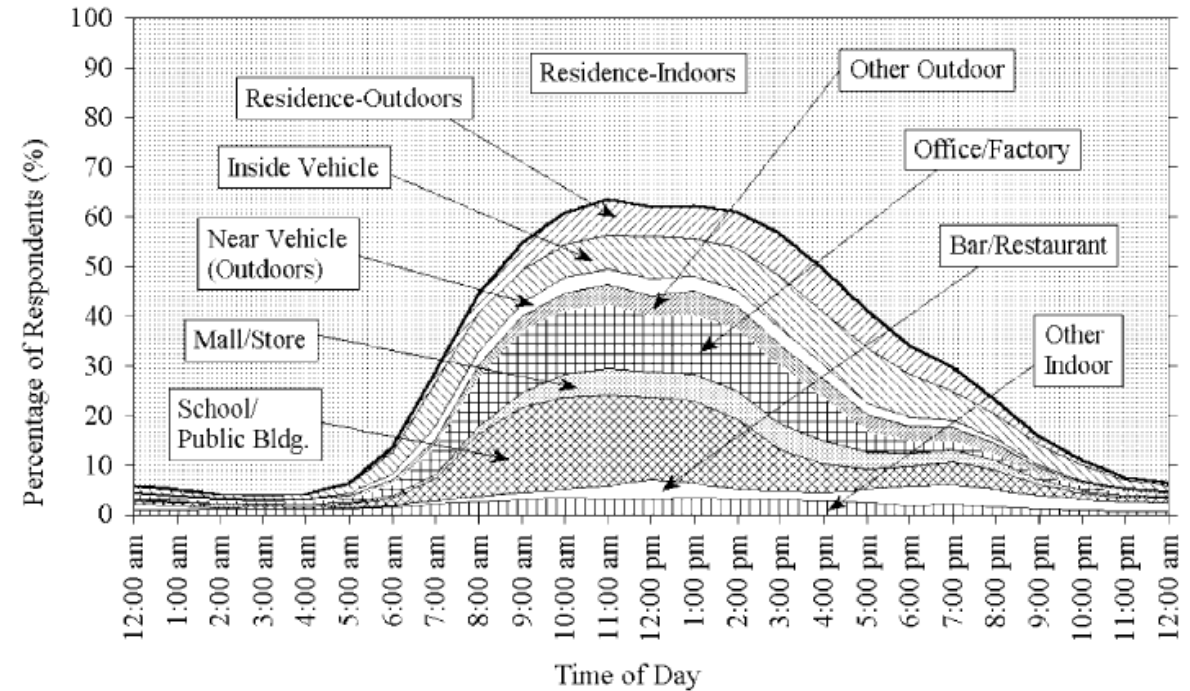
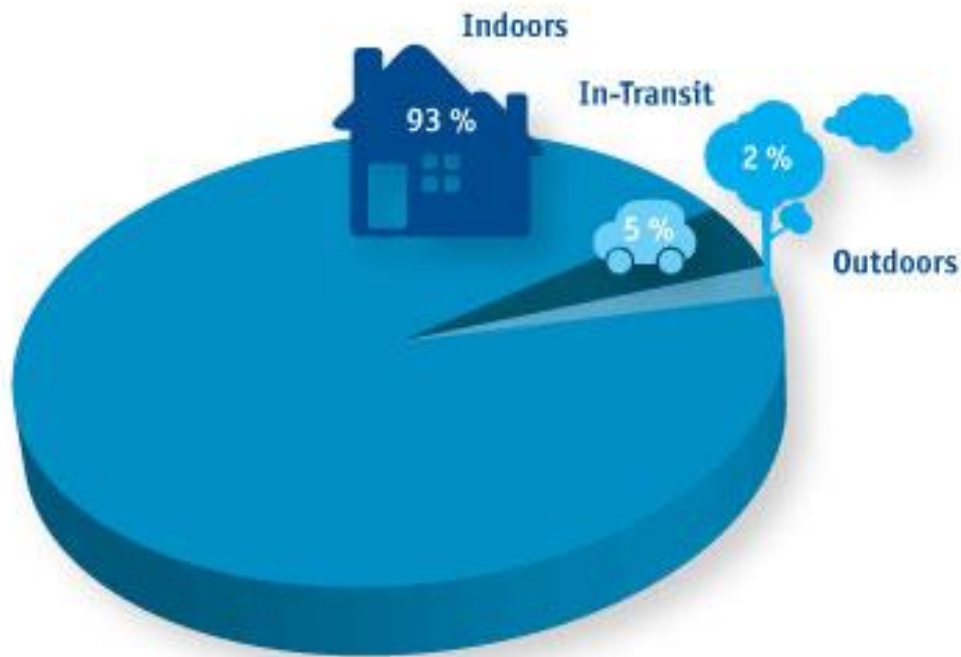
We take 20 000 breaths per day.

In comparison:

~1 kg of food

~1,5 kg / 0,0015 m³ of water

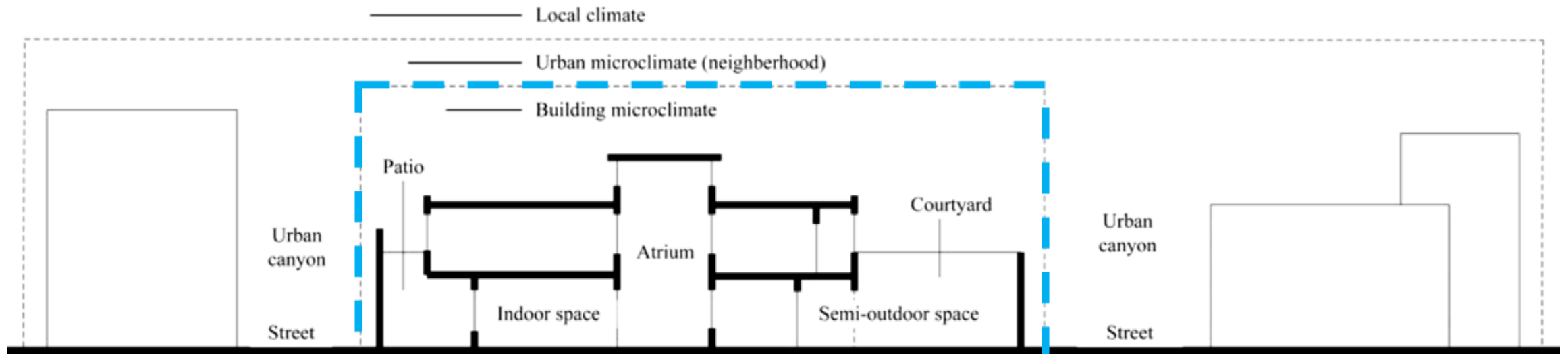
~15 kg / 15-20 m³ of air



Klepeis et al., 2001 "The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants"

Humans have become an indoor species

BUILDING MICROCLIMATE



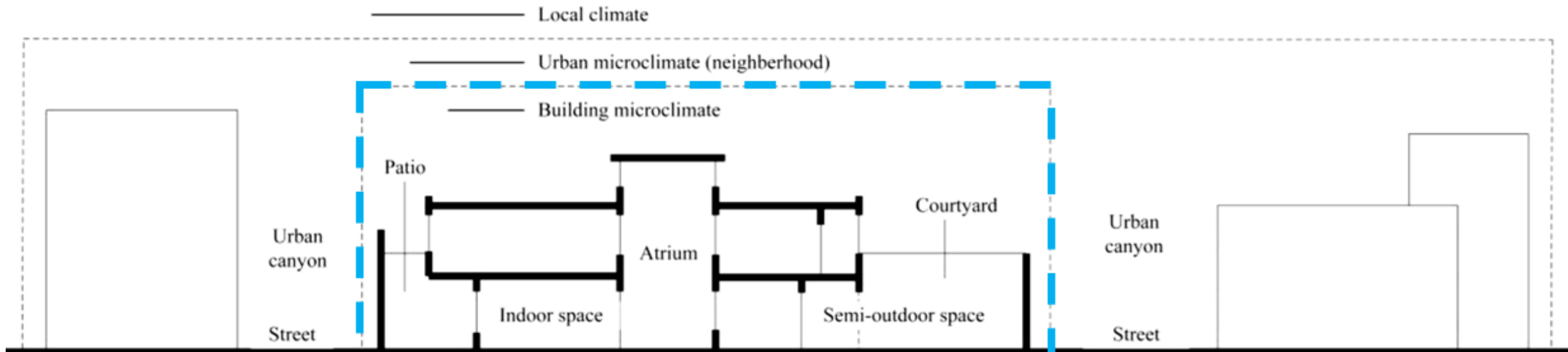
DEFINITIONS

Ventilation

- **intentional** process of exchanging indoor air with outdoor air within a building or enclosed space

Infiltration

- **unintentional** entry of outdoor air into a building through cracks, gaps, leaks, or other openings in the building envelope



Siseõhu saasteained: SISEÕHU SAASTEAINETE MASSIBILANSS

t – aeg, s
 V – ruumi maht, m^3
 C – kontsentratsioon, $\mu g/m^3$
 Q – mahtvooluhulk, m^3/s
 E – emissiooni intensiivsus, $\mu g/m^3$
 ε - puhastusaste, %
 T – temperatuur, $^{\circ}C$
 RH – õhu suhteline niiskus, %

Väliskeskkond
 $C_{võ}$

Infiltratsioon
 Q_{inf}

Ventilatsioon
 Q_{vent}

Õhu puhastamine
 Q_{puh}

Sisekeskkond:

- V
- $C_{sõ}$
- T
- RH

Eksfiltratsioon
 Q_{eksf}

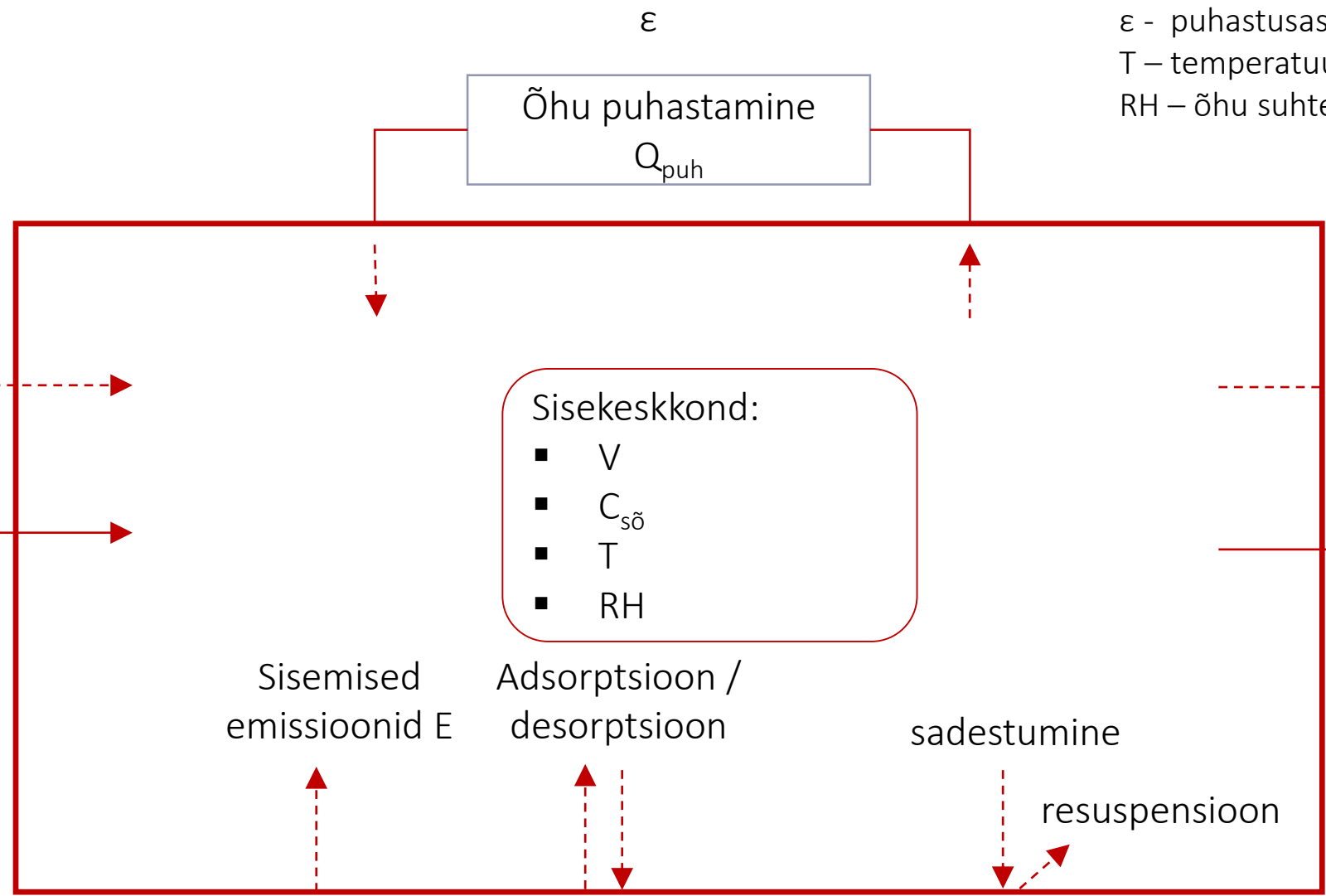
Ventilatsioon
 Q_{vent}

Sisemised
emissioonid E

Adsorptsioon /
desorptsioon

sadestumine

resuspensioon



Ventilation airflow is driven by
pressure difference

VENTILATION TYPES

Natural ventilation

airflow driven by natural forces (wind and buoyancy)

Mechanical ventilation

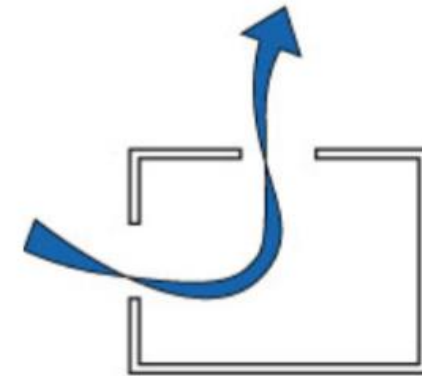
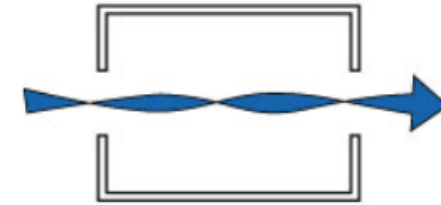
airflow driven by fans

Hybrid ventilation

combination of natural and mechanical ventilation

NATURAL VENTILATION (loomulik ventilatsioon)

- **Single-sided ventilation**
 - ΔP **wind** (tuul)
- **Cross ventilation**
 - ΔP **wind** (tuul)
- **Stack ventilation**
 - ΔP **buoyancy** (üleslükkejõud)
 - Key elements
 - Temperature difference
 - Vertical path



Natural ventilation doesn't mean doing nothing and leaving air exchange to chance.



PRINCIPLES

Indoor environmental quality is the objective

Indoor air quality

Thermal comfort

Sound

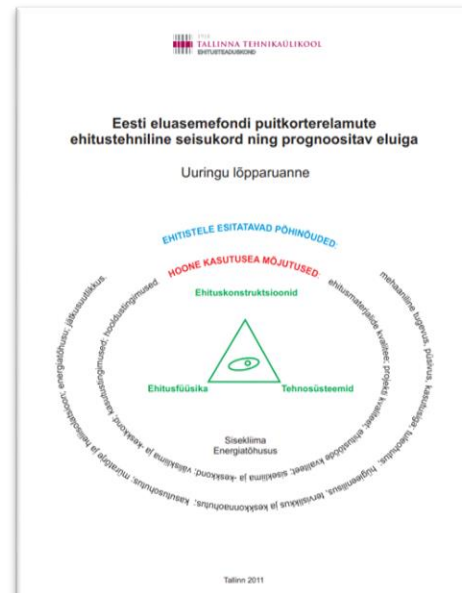
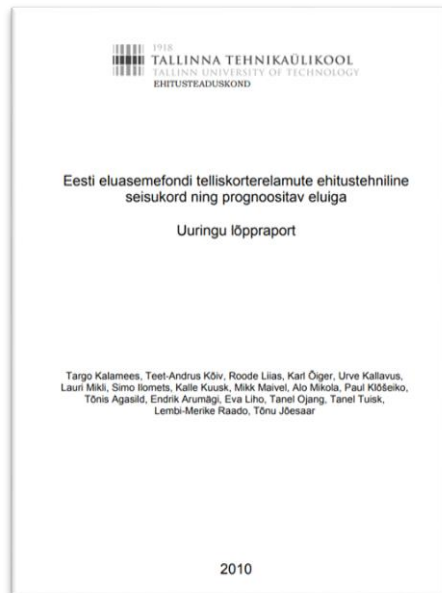
Lighting

Ventilation is not an energy-efficiency measure

IEQ parameters should be controlled during occupancy

RESEARCH STUDIES IN ESTONIA

- Brick apartment building (telliskorterelamud)
 - Prefabricated panel buildings (paneelalamud)
 - Wooden apartment buildings (puitkorterelamud)
 - Alo Mikola PhD dissertations
- **Conclusion**
 - Natural ventilation does not guarantee required ventilation rate throughout the year



WHAT IS ESTONIAN PERSPECTIVE?

- **Regulations**

- Sotsiaalministeeriumi määrus Eluruumile esitatavad nõuded
 - *„Eluruumis peab olema loomulik või mehaaniline ventilatsioon, mis tagab inimese elutegevuseks vajaliku õhuvahetuse.“*
- Minimum requirements for building energy efficiency
- Korterelamute rekonstrueerimise toetuse andmise tingimused ja kord
 - *Mechanical ventilation must be installed*

§ 13. Tehnosüsteemi nõuded

(1) Tehnosüsteem tuleb projekteerida ja paigaldada nii, et oleks tagatud selle pikaajaline ja efektiivne töötamine optimaalses tööpiirkonnas.

(2) Siseõhu kvaliteet tagatakse soojustagastusega sissepuhke- ja väljatõmbeventilatsiooniga. Ventilatsioonisüsteemis kasutatakse efektiivset soojustagastust, madala rõhulanguga torustikku ja ventilatsiooniseadme komponente ning kõrge kasuteguriga ventilaatorit ja juhtseadet.

(3) Soojustagastusega sissepuhke- ja väljatõmbeventilatsiooni paigaldamine ei ole nõutud, kui:

1) soojusallikas on väljatõmbeõhu soojuspump;

2) selleks puudub ehituslik võimalus;

[RT I, 22.08.2019, 1 - jõust. 25.08.2019]

3) väljatõmbeõhk sisaldab saasteaineid, mida ei tohi soojustagastisse juhtida;

3¹) ventilatsioonisüsteemi kavandatud tööaeg on lühem kui neli tundi ööpäevas;

[RT I, 22.08.2019, 1 - jõust. 25.08.2019]

4) olulisel rekonstrueerimisel ei ole ventilatsioonitorustikku paigaldamine hoonesse tehniliselt võimalik või

5) hoone nõutav energiatõhususe tase, siseõhu kvaliteet ja soojuslik mugavus tagatakse lõikes 2 nimetatust erineva õhuvahetuse süsteemiga.

EESTI STANDARD **EVS-EN 16798-1:2019+NA:2019**

Avaldatud eesti keeles koos rahvusliku lisaga: oktoober 2019
Jõustunud Eesti standardina: oktoober 2019

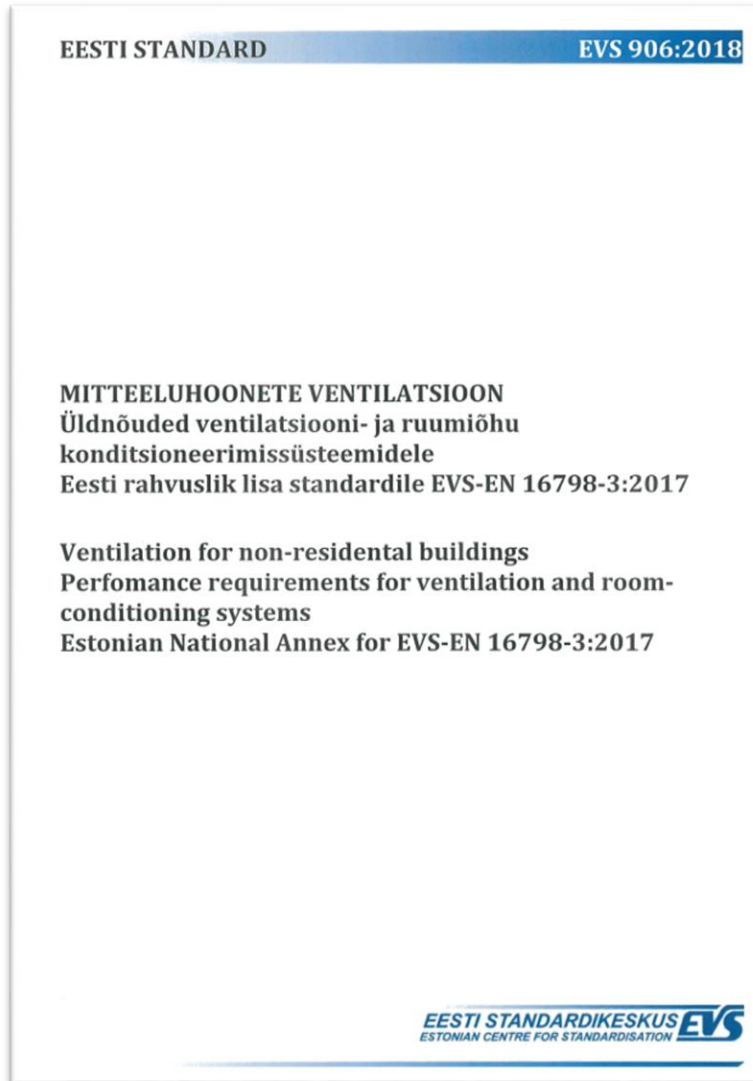
HOONETE ENERGIATÕHUSUS
Hoonete ventilatsioon
Osa 1: Sisekeskonna lähteandmed hoonete energiatõhususe projekteerimiseks ja hindamiseks, lähtudes siseõhu kvaliteedist, soojuslikust keskkonnast, valgustusest ja akustikast
Moodul M1-6

Energy performance of buildings
Ventilation for buildings
Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics
Module M1-6

EESTI STANDARDIKESKUS **EVS**
ESTONIAN CENTRE FOR STANDARDISATION

- Ventilation types
 - Natural
 - Mechanical
 - Hybrid
- Every ventilation system type should be designed according to the required airflow rates

Peamiste ruumide arv korteris	Arvutuslik väljatõmbeõhu vooluhulk l/s				
	Köök	Vannituba või duširuum koos tualettidega või ilma nendeta	Teised märjad ruumid	Tualetid	
				Üks korter	Mitu (2 või enam korterit)
1	20	10	10	10	10
2	25	10	10	10	10
3	30	15	10	10	10
4	35	15	10	15	10
5 ja rohkem	40	15	10	15	10



- Ventilation types
 - Natural
 - Mechanical
 - Hybrid -> but may not function at the same time
- Airflow direction must be controllable
- Mechanical ventilation -> the go-to solution
- Natural ventilation as exception
 - Unconditioned (technical) rooms
 - Simpler buildings when energy-efficiency is demonstrated

HISTORIC PRESERVATION (Muinsuskaitse)

- **Heritage Conservation Act** (Muinsuskaitseseadus)
 - Special conditions for heritage conservation
 - Visible components of duct system
 - Exhaust stacks of roofs
 - Location of mechanical equipment
 - Location of air diffusers
- **No energy efficiency requirements**
- **Practical experience**
 - Although there are no energy efficiency requirements for heritage buildings, the owners mostly prefer heat-recovery mechanical ventilation because overall it's cheaper.

SOME REFERENCES (Peeter Parre, IB Aksiaal)

Kadriorg Palace (Kadrioru loss)



Foto: A.Savin

- **Mechanical ventilation**
 - Air quality
- **Air conditioning**
 - Temperature control
 - Humidity control

Tallinn City Archives (Tallinna Linnaarhiiv)



Foto: Taivo Pungas

SOME REFERENCES (Peeter Parre, IB Aksiaal)

Estonian Academy of Sciences (Teaduste Akadeemia)



Foto: Ave Maria Mõistlik

- Mechanical ventilation
- Natural ventilation
 - 1st and 2nd floor
 - Air supply through windows

MANORS (Mõisad)

- Originally **one-family dwelling**
- **Now ...**
 - Restaurants
 - Schools
 - Hotels
 - Spas
 - Concert halls
 - Conference rooms
 - etc



Vihula mõis (Foto: Ivar Leidus)



Tõstamaa mõis (Foto: Toomas Mitt)

CONCLUSION

Modern buildings are airtight and well-insulated, and both energy efficiency requirements and overall higher indoor environmental quality standards have made **natural ventilation impractical in Estonian cold climate.**

CONCLUSION

- Uncontrolled and unregulated air exchange
- Cannot guarantee consistent and adequate ventilation
- Reduced air exchange in warmer weather
- Significant heat loss (higher heating costs) - heat recovery cannot be used
- Noise from outdoors
- Air pollution from external openings



**THANK YOU FOR YOUR
ATTENTION!**

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