P5

Graduation

Thomas Koenes
4648110
25-06-2019

Mentors
Marcel Bilow
Regina Bokel

TU Delft

Introduction

Literature

Case study

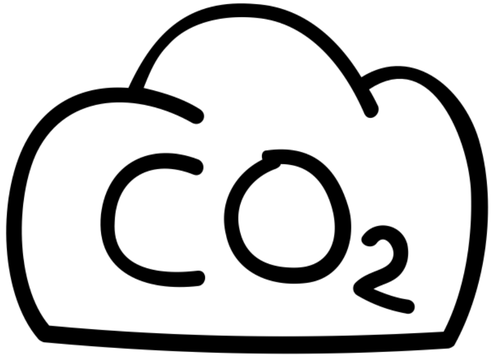
Design

Feasibility

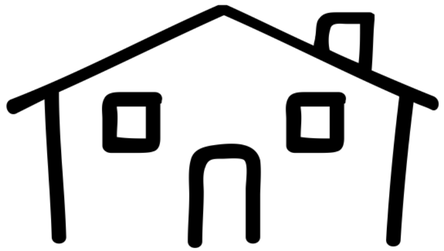
Conclusion

Introduction

40% energy consumption



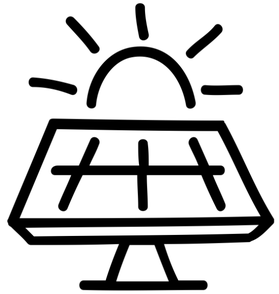
36% CO_2 emmision

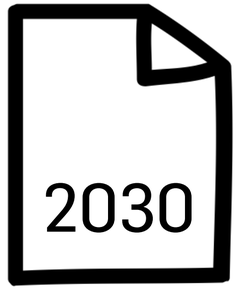


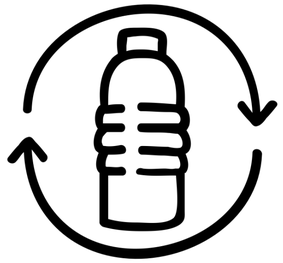
Built environment

(European Commission, 2018)

Introduction







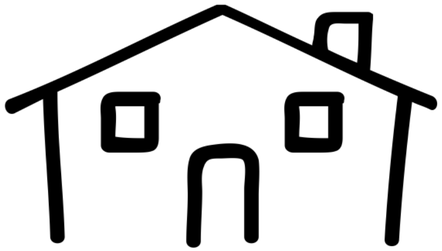
Energy label A

(Sociaal-Economische Raad, 2013)

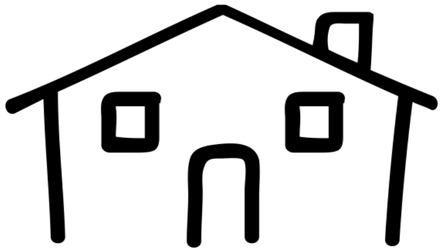
Introduction

Calculated energy savings on gas is 81%

Energy label G



Energy label A



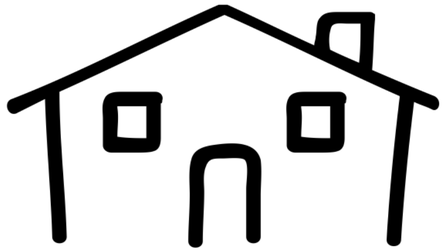
Energy savings on gas is 38% in practice

(Majcen, D., & Itard, L. 2014)

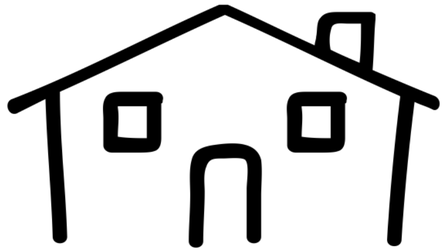
Introduction

Difficult te determing parameters

Energy label G



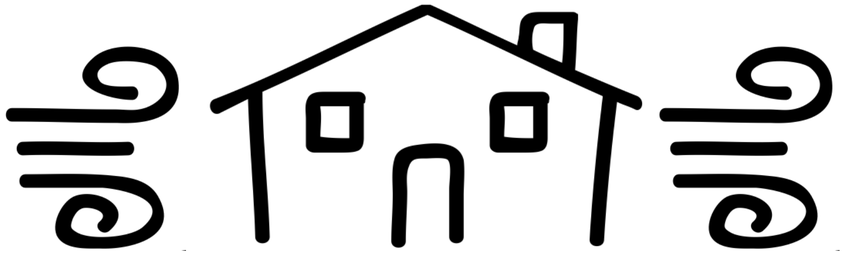
Energy label A



U-values
Infiltration
User behavior

(Majcen, D., & Itard, L. 2014)

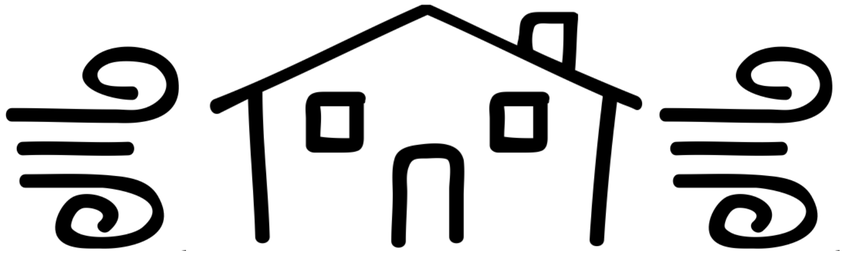
Introduction



Reduction of indoor air pollutants
Creates safe and comfortable IAQ

Increases the air change rate
Increase energy demand

Introduction



Simulation
Heating demand increases by 13%, 35% or 61%

Real world test
Heating demand increases by 2,4%

(D'Oca, Corgnati, Fabi, & Andersen, 2014)
(Moghadam, Soncini, Fabi, & Corgnati, 2015)
(Jack, Loveday, Allinson, & Lomas, 2015)

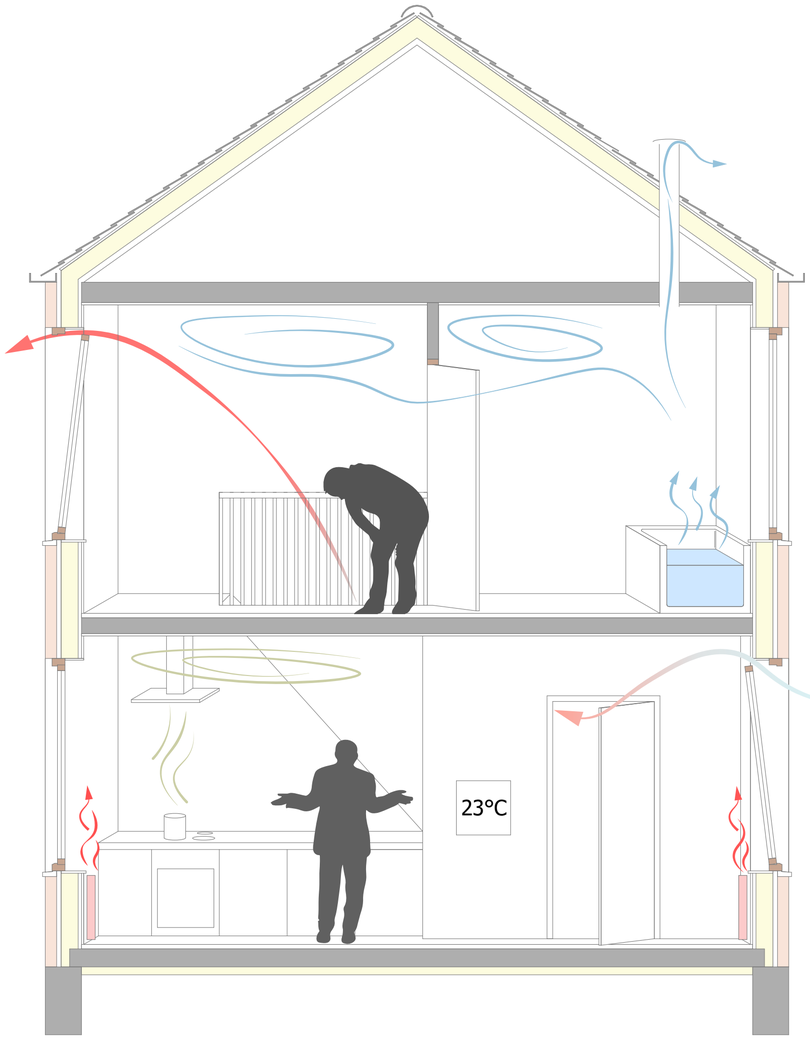
Introduction

Problemstatement

Thermal energy loss

Heating of unoccupied room

Accumulation of indoor air pollutants



High humidity

10°C

Ventilate with polluted air

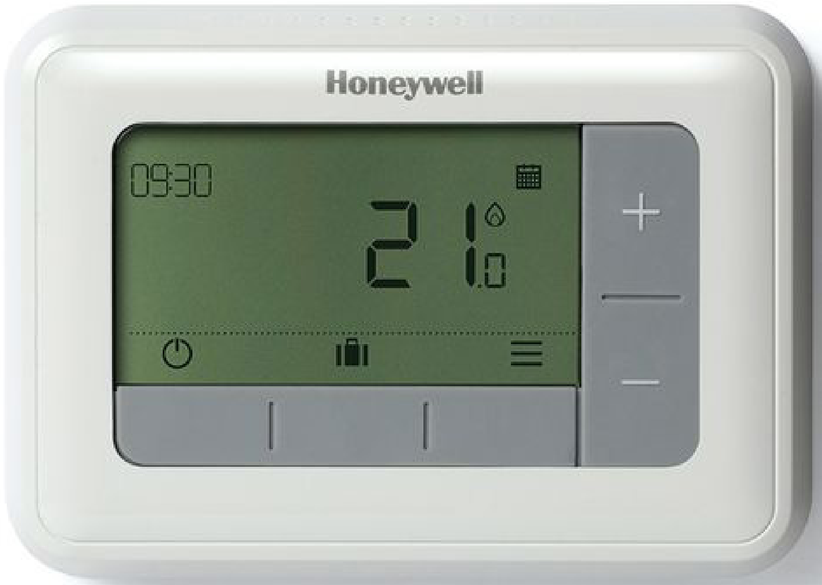
Introduction

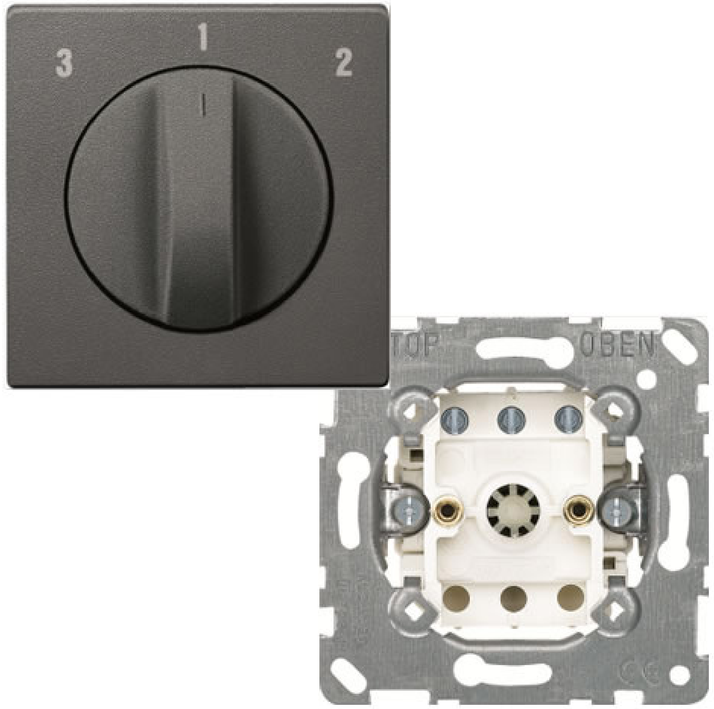
Main question

In which way can a new system effectively assist users to reduce the energy demand for heating and cooling of a residential building, while creating a safer and more comfortable indoor air quality?

Literature

Indoor comfort





(Honeywell, n.d.)
(Elektroshop, n.d.)

Literature

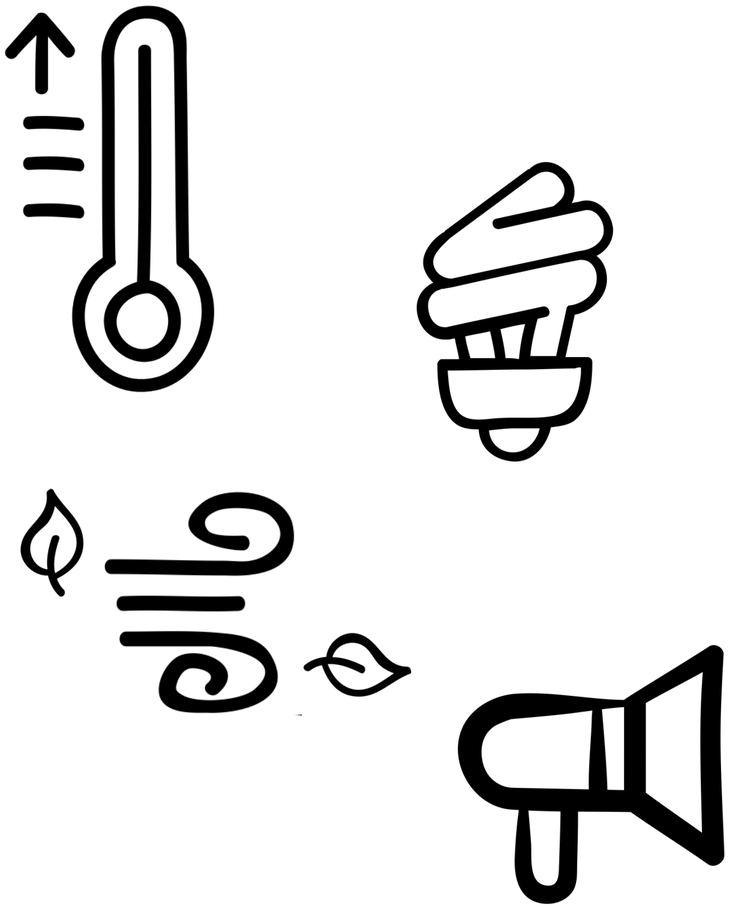
Design

Thermal comfort and indoor air quality for classrooms

Francesca Stazi, professor Building science and Technology at Università Politecnica delle Marche

Literature

Comfort



thermal comfort

visual or lighting quality

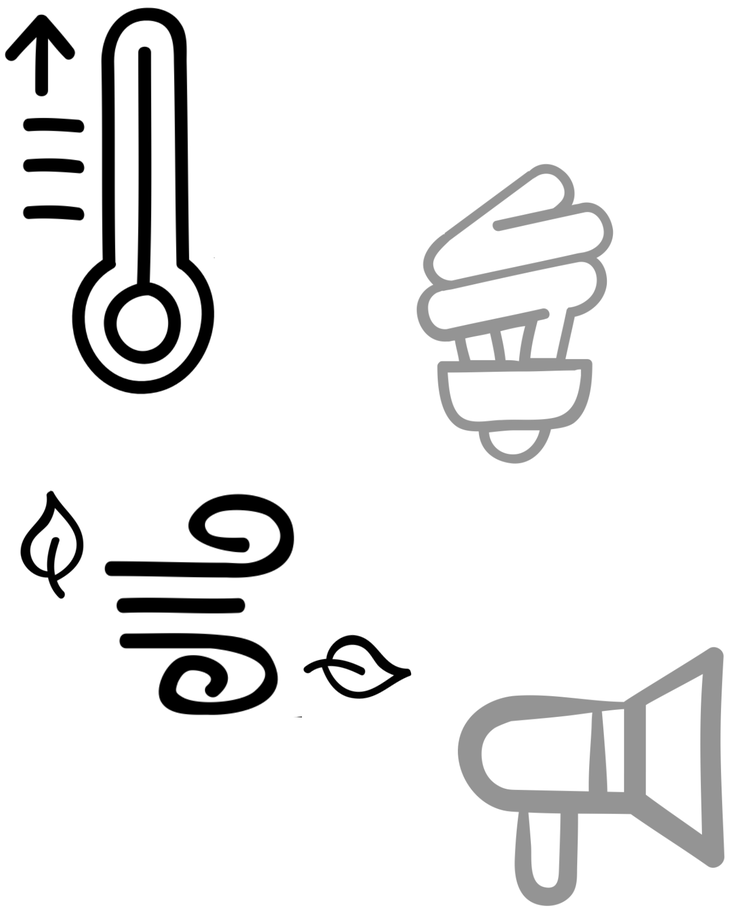
air quality

acoustical quality

(Bluyssen, 2009)

Literature

Comfort



thermal comfort

visual or lighting quality

air quality

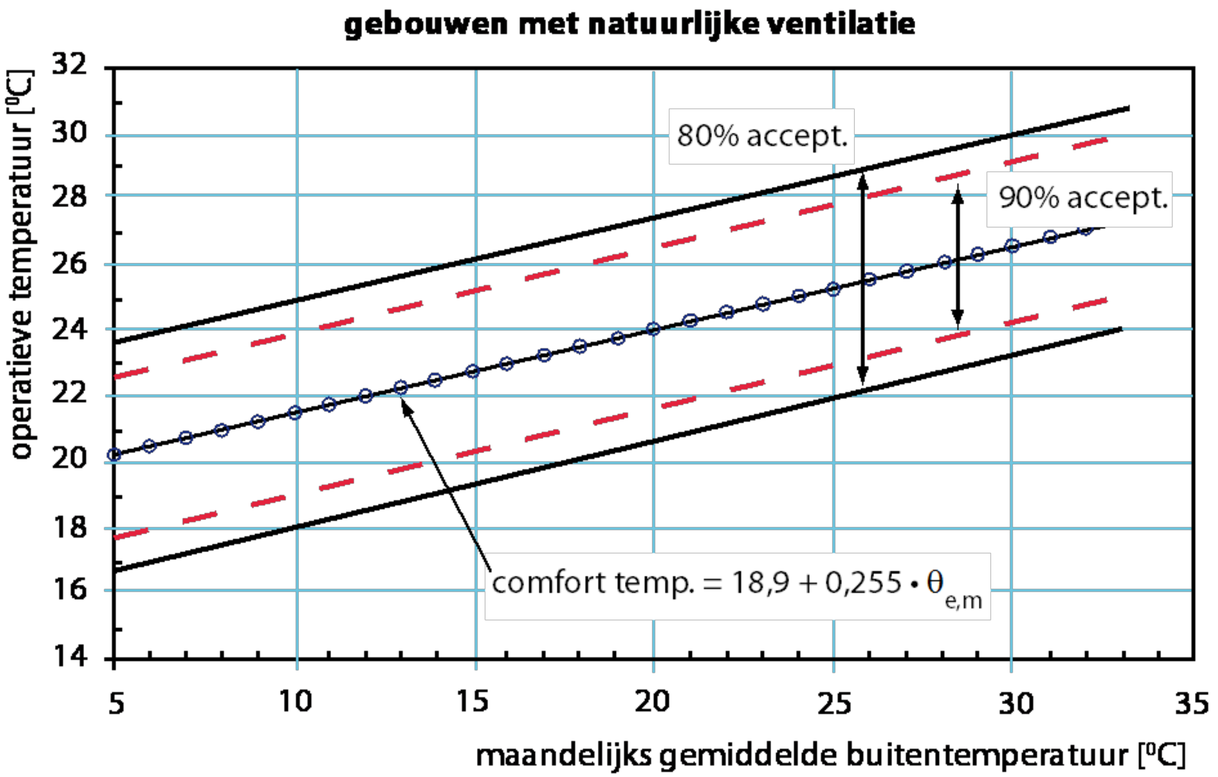
acoustical quality

(Bluyssen, 2009)

Literature

Comfort

Thermal comfort



Air quality

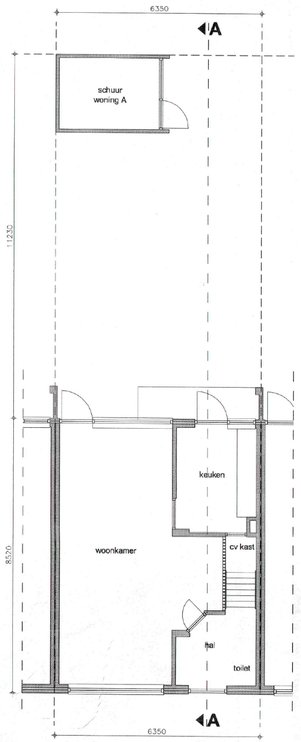
Threshold set by the World Health organization

(World Health Organization, 2013)
(Normcommissie 351 074 “klimaatbeheersing in gebouwen”, 2007)

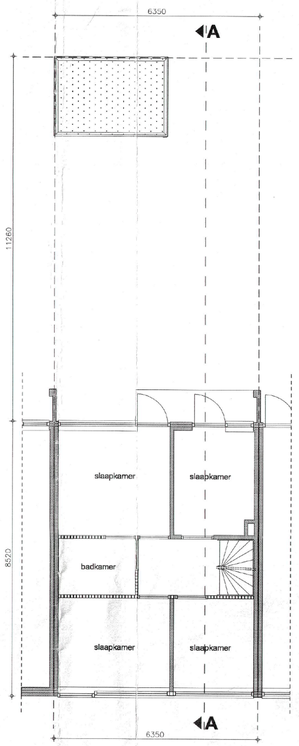
Case study
Location

achtergevelaanzicht
(bestaande situatie)

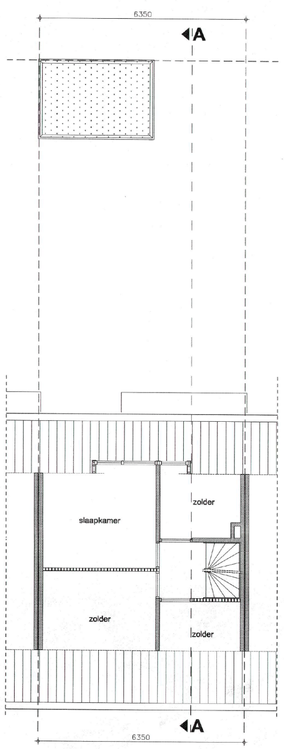
achtergevelaanzicht
(nieuwe situatie)



begane grond
(bestaande situatie)



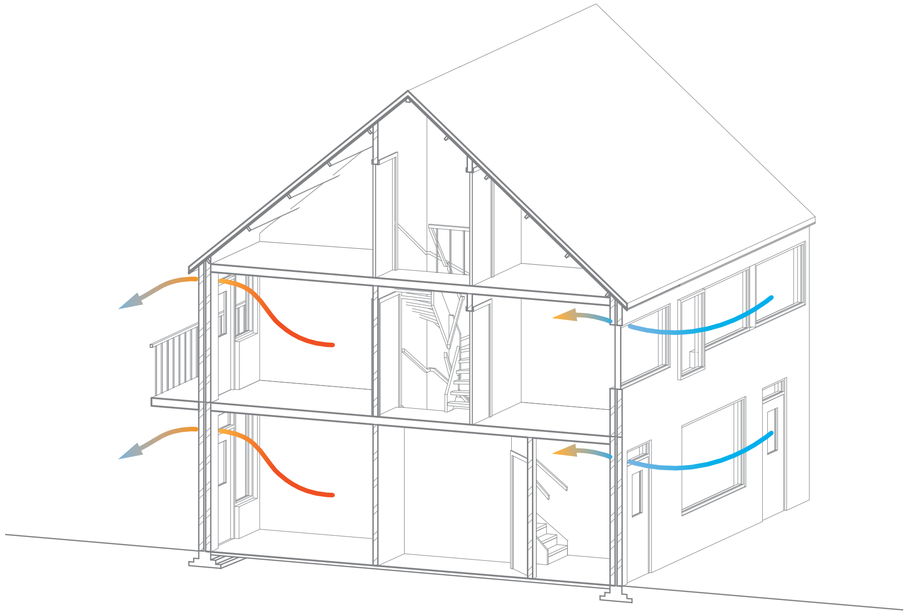
eerste verdieping
(bestaande situatie)



tweede verdieping
(bestaande situatie)

Case study

Ventilation and infiltration



Ventilation grill

Cracks and poor connections

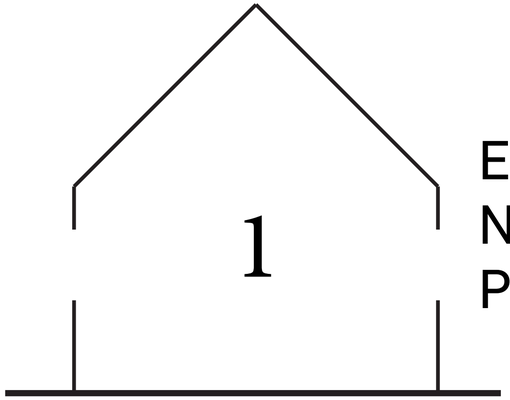
Case study

Strategy

Strategy 1, Bouwbesluit	match regulations constant ventilation rate
Strategy 4, Threshold	improve IAQ ventilates in order to keep indoor pollutants below certain threshold
Strategy 5, Balanced	improve IAQ and lower thermal loss allows higher indoor pollutants

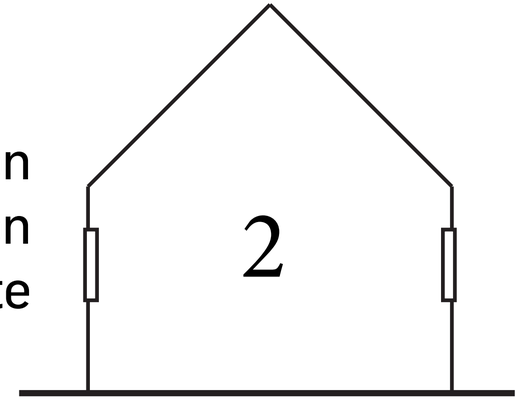
Case study

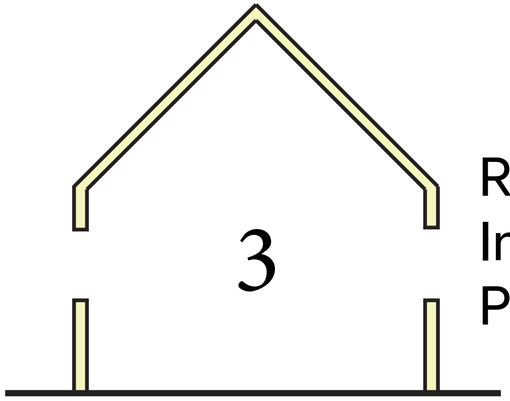
Energy saving potentials



Existing building
No insulation
Poor infiltration rate

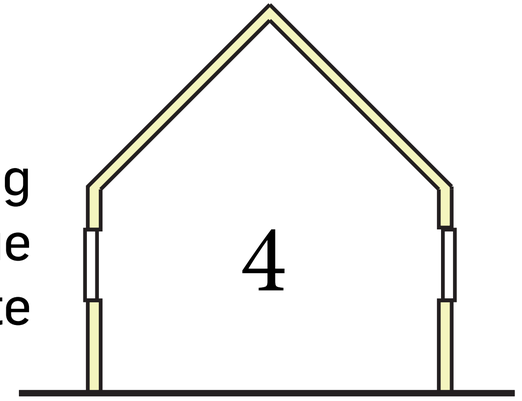
Upgraded infiltration
No insulation
Improved infiltration rate





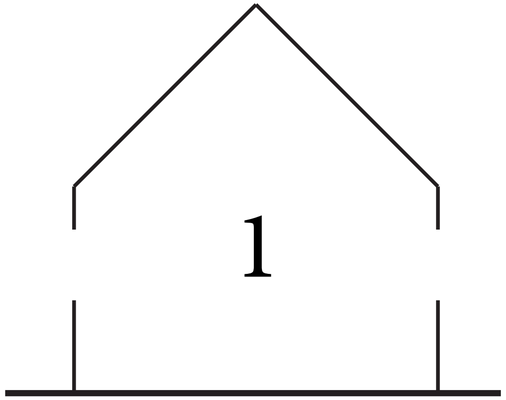
Renovation
Improved Rc-value
Poor infiltration rate

New building
Improved Rc-value
Improved infiltration rate



Case study

Energy saving potentials



Strategy 1
19,8 mWh/year

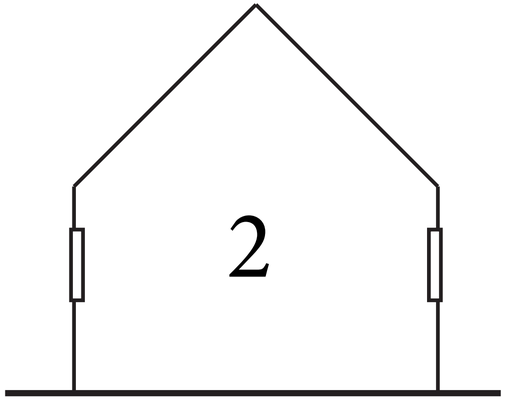
Strategy 2
15,7 mWh/year

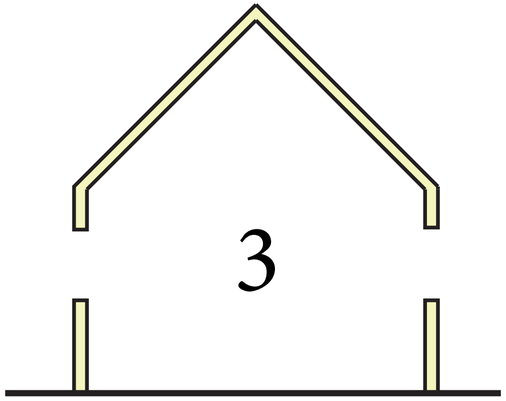
Strategy 3
14,2 mWh/year

Strategy 1
16,9 mWh/year

Strategy 2
14,4 mWh/year

Strategy 3
12,9 mWh/year





Strategy 1
12,5 mWh/year

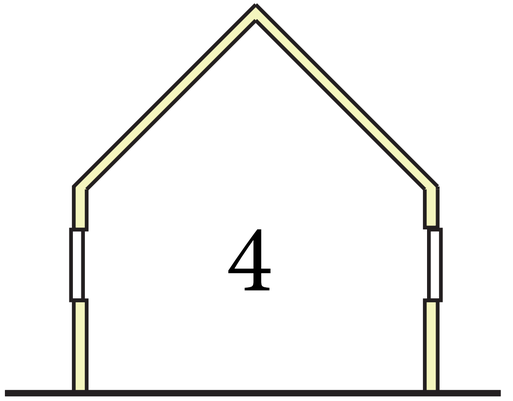
Strategy 2
10,5 mWh/year

Strategy 3
9,1 mWh/year

Strategy 1
10,5 mWh/year

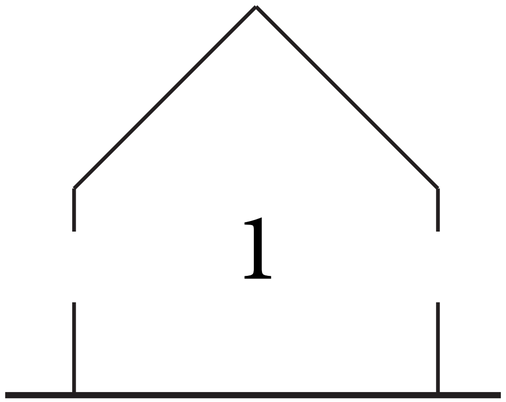
Strategy 2
9,1 mWh/year

Strategy 3
7,7 mWh/year



Case study

Energy saving potentials



Strategy 1
19,8 mWh/year

21%

Strategy 2
15,7 mWh/year

28%

Strategy 3
14,2 mWh/year

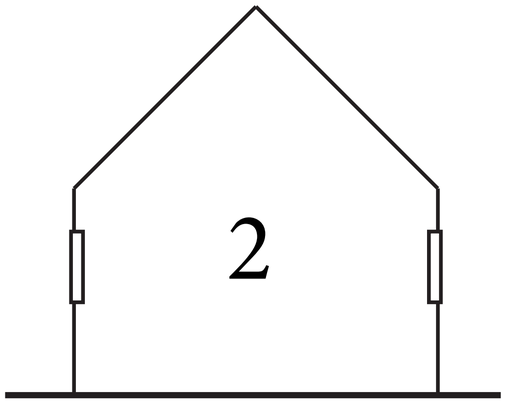
Strategy 1
16,9 mWh/year

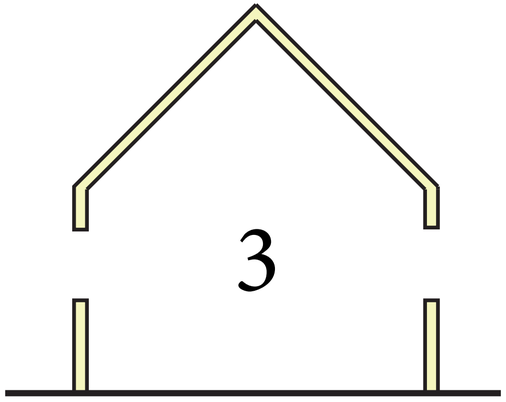
14%

Strategy 2
14,4 mWh/year

23%

Strategy 3
12,9 mWh/year





Strategy 1
12,5 mWh/year

16%

Strategy 2
10,5 mWh/year

27%

Strategy 3
9,1 mWh/year

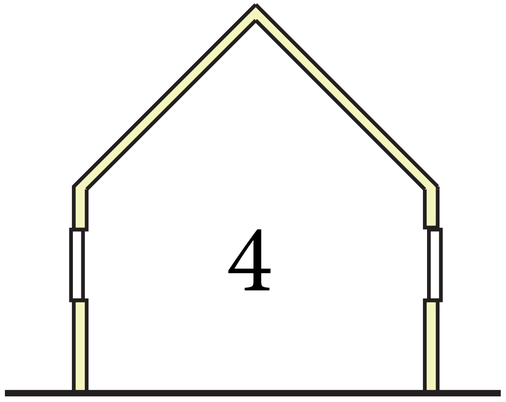
Strategy 1
10,5 mWh/year

14%

Strategy 2
9,1 mWh/year

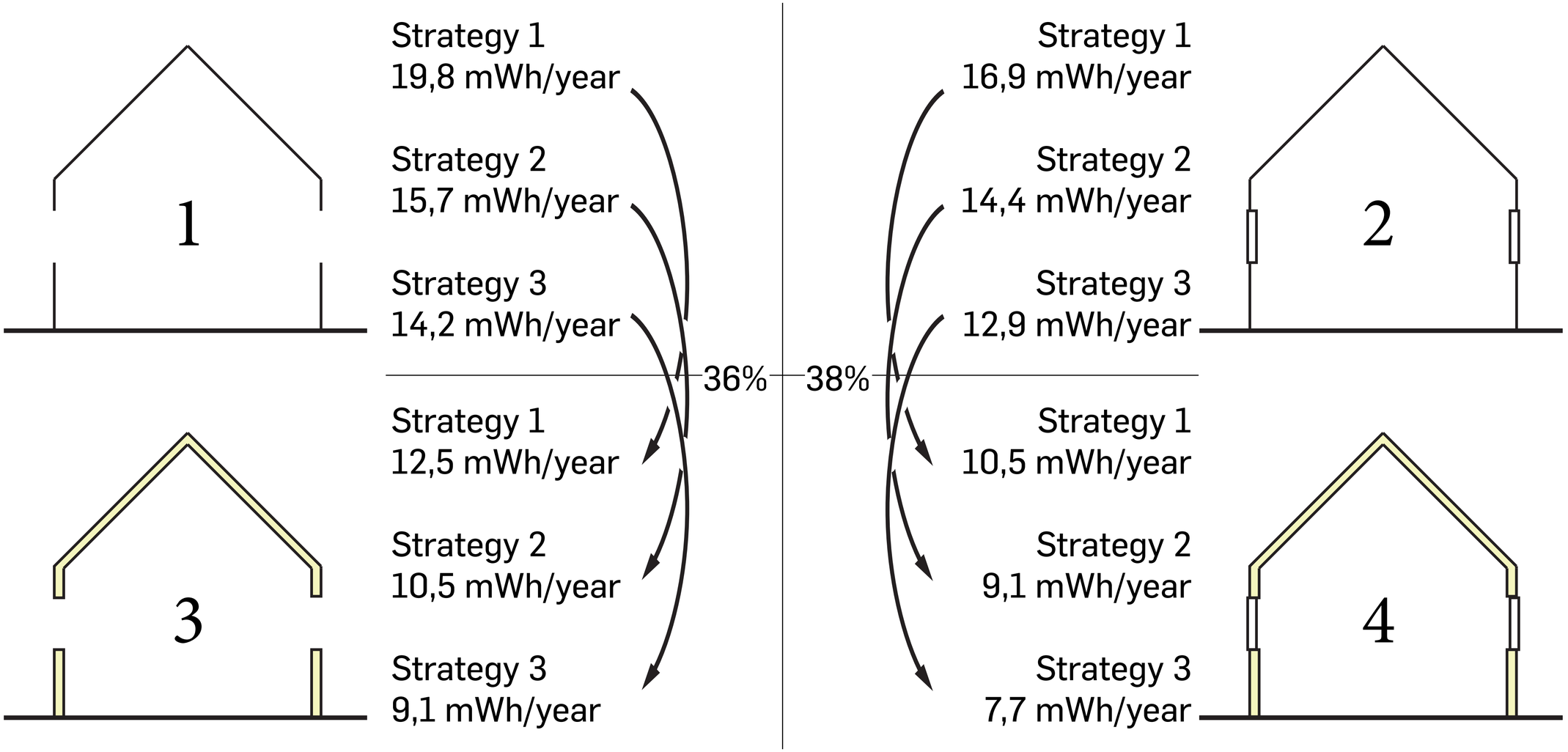
27%

Strategy 3
7,7 mWh/year



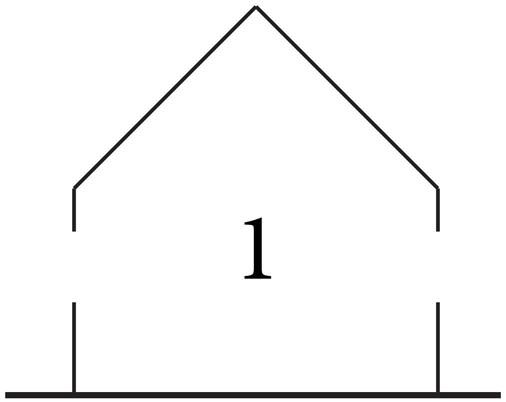
Case study

Energy saving potentials



Case study

Energy saving potentials



Strategy 1
19,8 mWh/year

15%

Strategy 1
16,9 mWh/year

Strategy 2
15,7 mWh/year

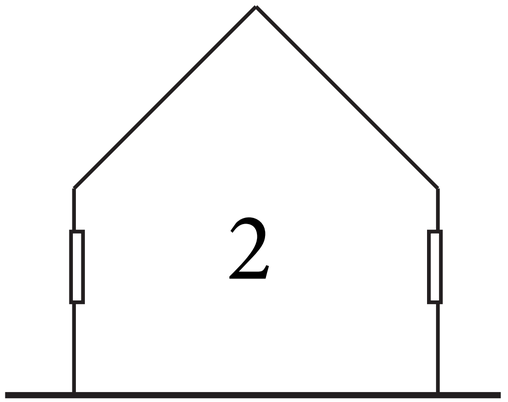
8%

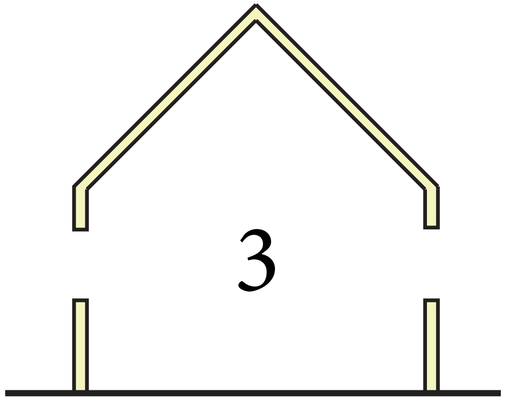
Strategy 2
14,4 mWh/year

Strategy 3
14,2 mWh/year

9%

Strategy 3
12,9 mWh/year





Strategy 1
12,5 mWh/year

16%

Strategy 1
10,5 mWh/year

Strategy 2
10,5 mWh/year

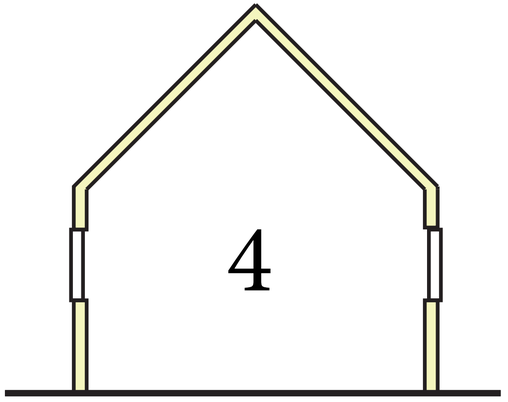
13%

Strategy 2
9,1 mWh/year

Strategy 3
9,1 mWh/year

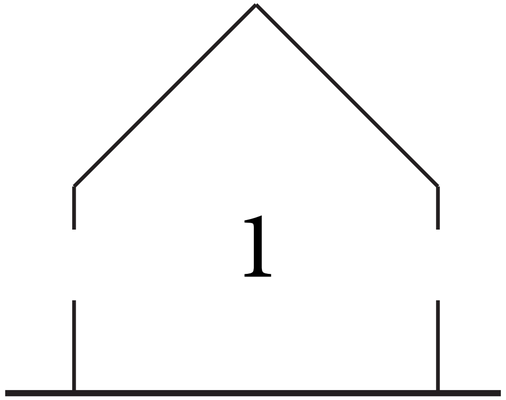
15%

Strategy 3
7,7 mWh/year



Case study

Energy saving potentials



Strategy 1
19,8 mWh/year

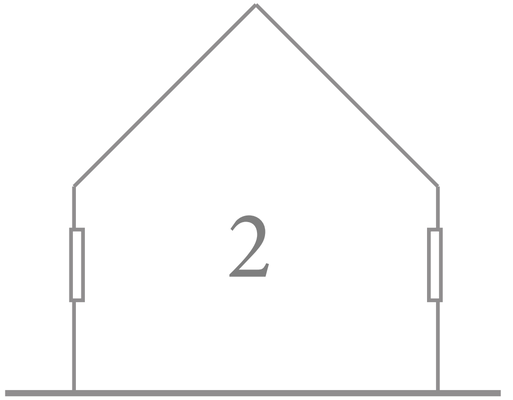
Strategy 2
15,7 mWh/year

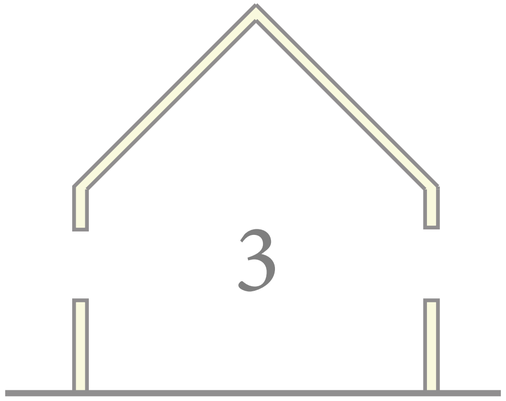
Strategy 3
14,2 mWh/year

Strategy 1
16,9 mWh/year

Strategy 2
14,4 mWh/year

Strategy 3
12,9 mWh/year





Strategy 1
12,5 mWh/year

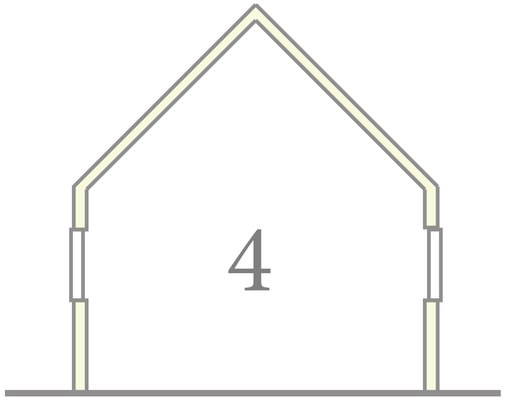
Strategy 2
10,5 mWh/year

Strategy 3
9,1 mWh/year

Strategy 1
10,5 mWh/year

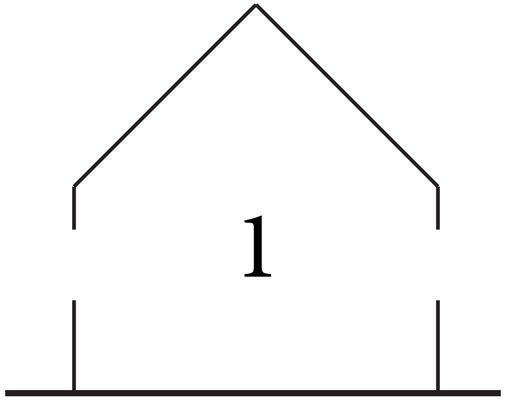
Strategy 2
9,1 mWh/year

Strategy 3
7,7 mWh/year



Case study

Energy saving potentials



Strategy 1
19,8 mWh/year

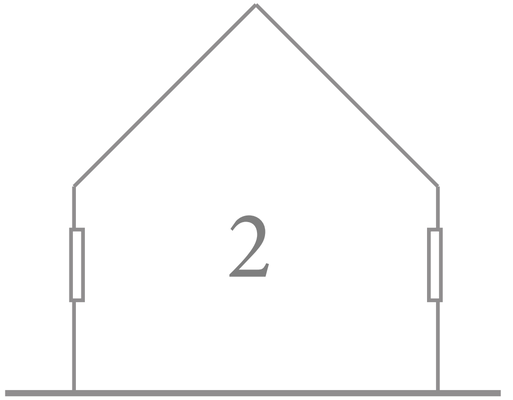
Strategy 2
15,7 mWh/year

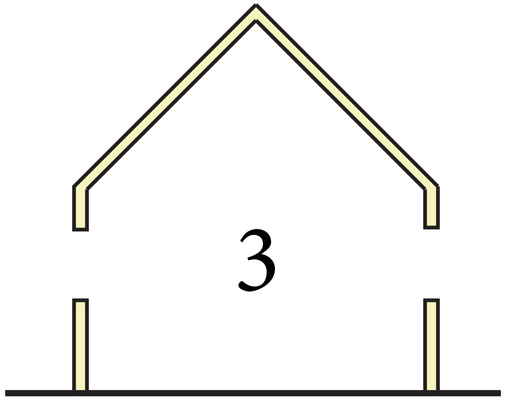
Strategy 3
14,2 mWh/year

Strategy 1
16,9 mWh/year

Strategy 2
14,4 mWh/year

Strategy 3
12,9 mWh/year





Strategy 1
12,5 mWh/year

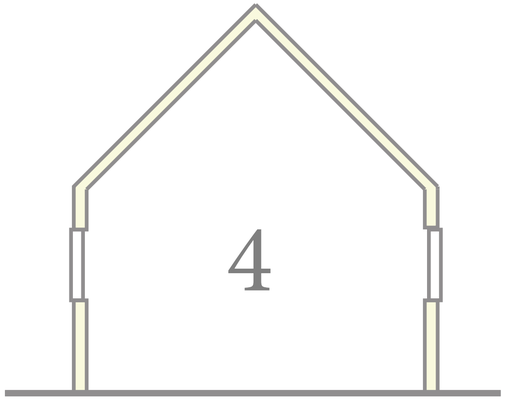
Strategy 2
10,6 mWh/year

Strategy 3
9,1 mWh/year

Strategy 1
10,5 mWh/year

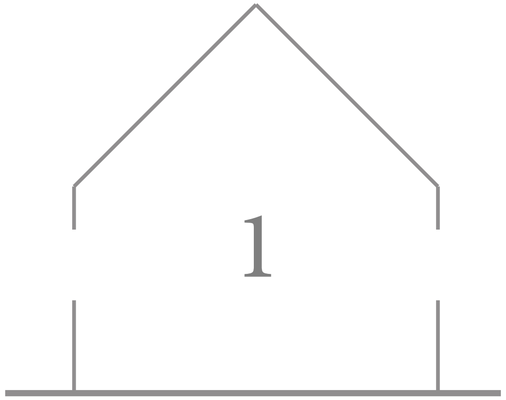
Strategy 2
9,1 mWh/year

Strategy 3
7,7 mWh/year



Case study

Energy saving potentials



Strategy 1
19,8 mWh/year

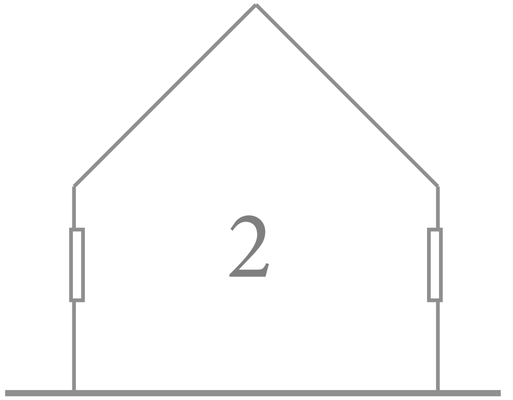
Strategy 2
15,7 mWh/year

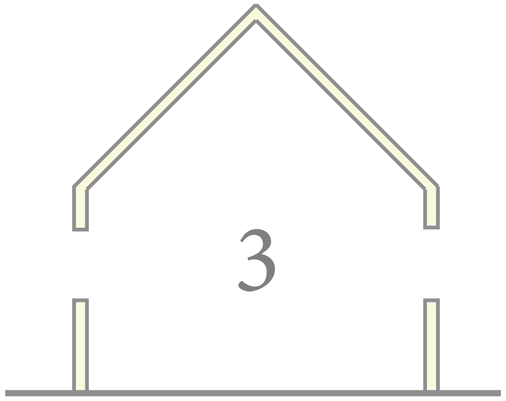
Strategy 3
14,2 mWh/year

Strategy 1
16,9 mWh/year

Strategy 2
14,4 mWh/year

Strategy 3
12,9 mWh/year





Strategy 1
12,5 mWh/year

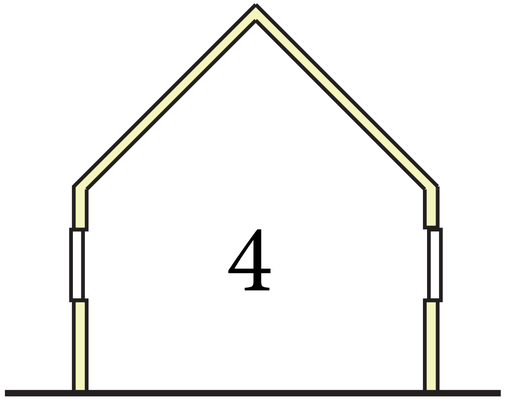
Strategy 2
10,6 mWh/year

Strategy 3
9,1 mWh/year

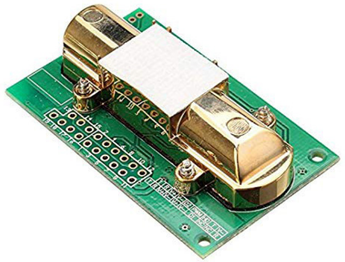
Strategy 1
10,5 mWh/year

Strategy 2
9,1 mWh/year

Strategy 3
7,7 mWh/year

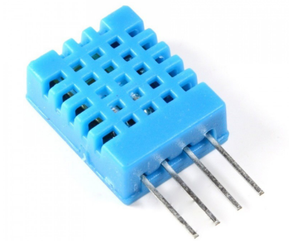


Design
Mechanism



MH-Z14a

(Opencircuit OÜ, n.d.)



DHT11

(Opencircuit OÜ, n.d.)

Display

(Opencircuit OÜ, n.d.)

Arduino Uno

(Opencircuit OÜ, n.d.)

AXA Remote 2.0

(AXA home security, n.d.)

Dual relay

(Opencircuit OÜ, n.d.)

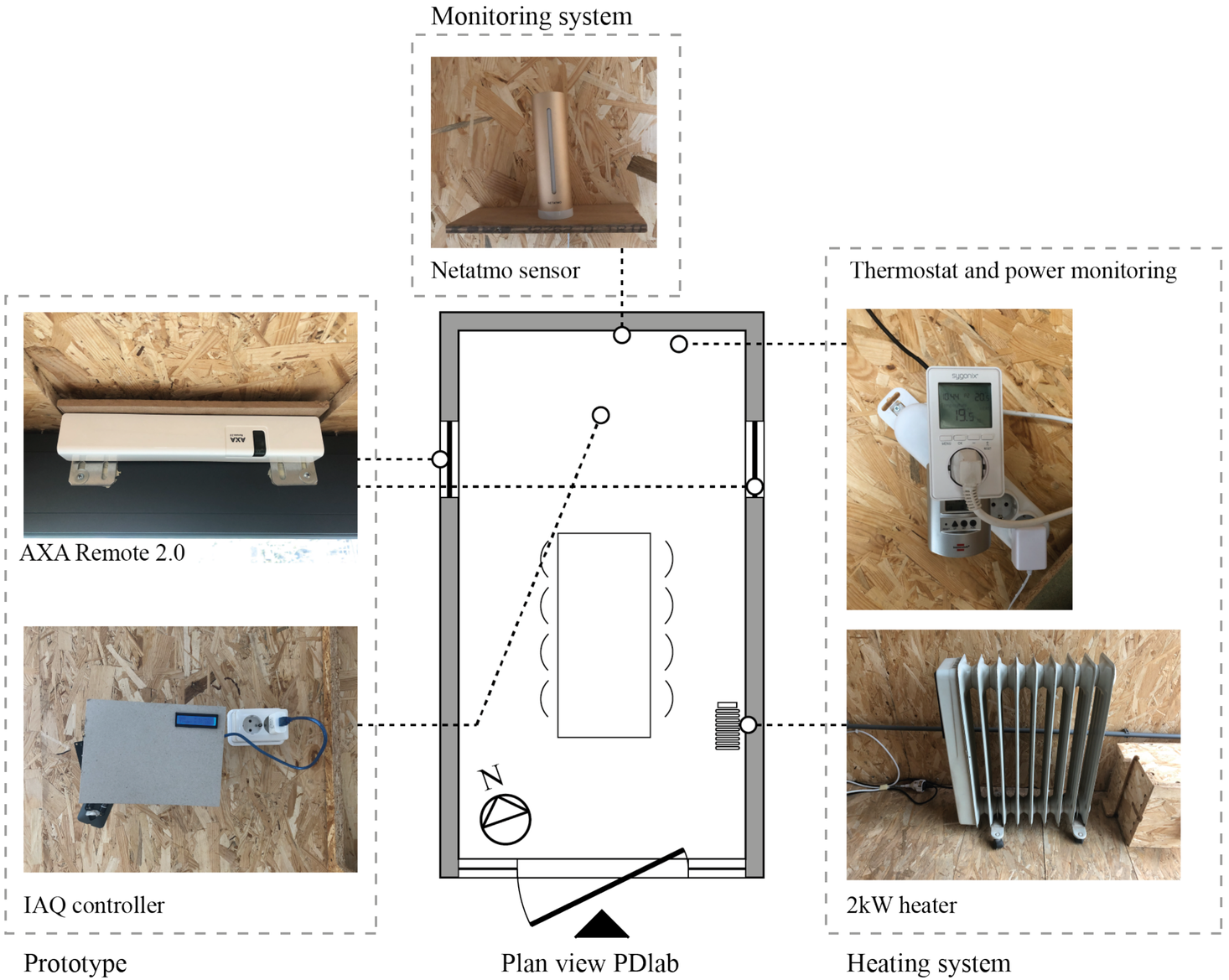
Design

Location

(The New Makers, n.d.)

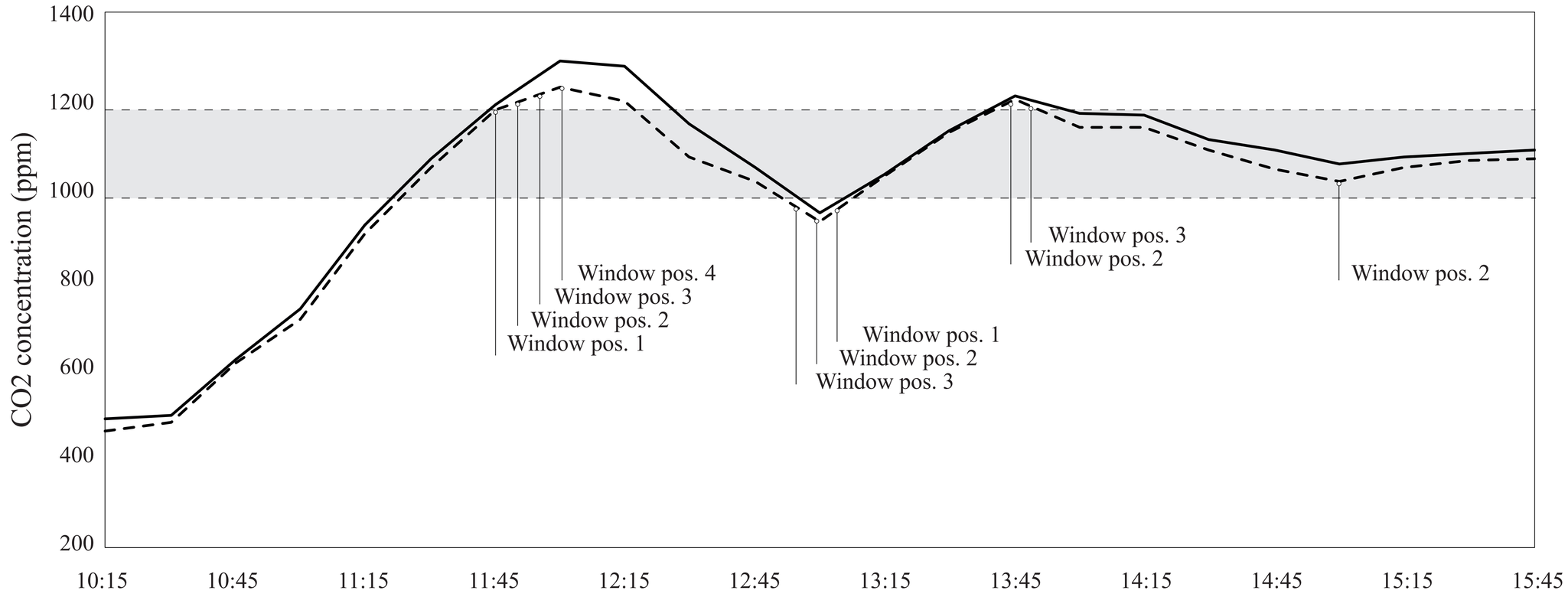
Design

Test setup



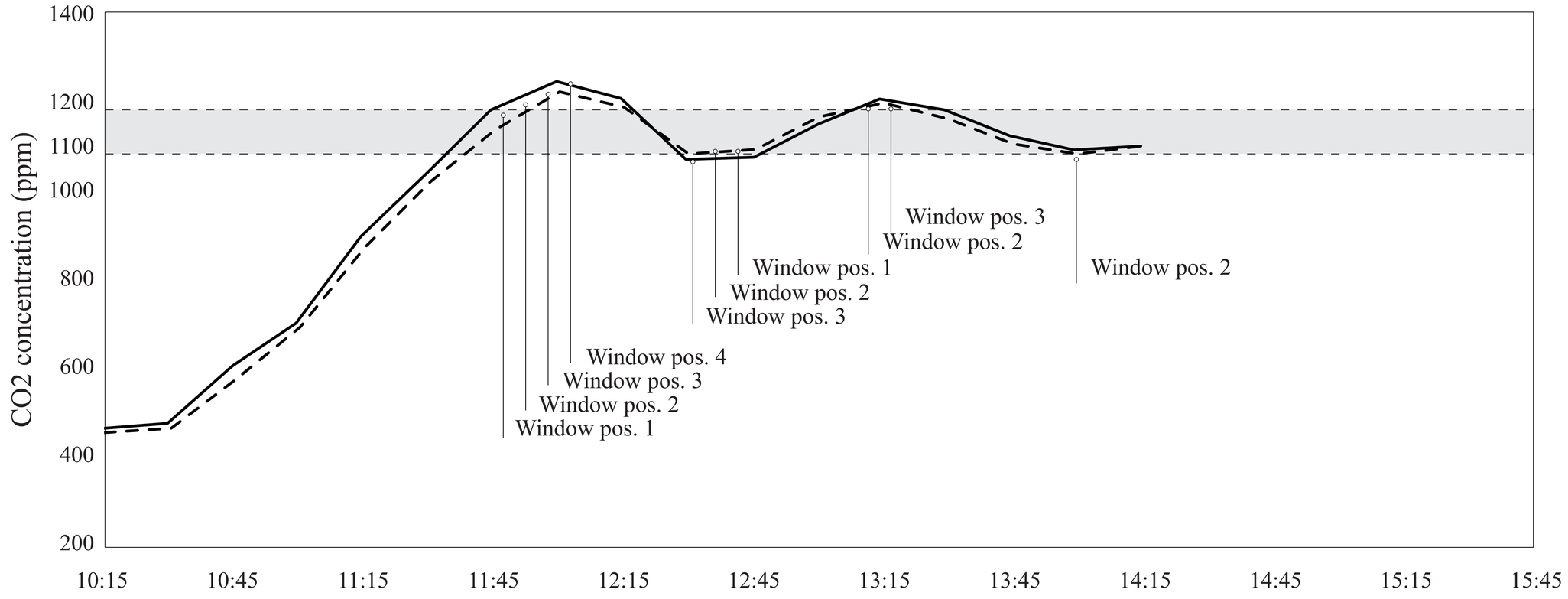
Design

Result



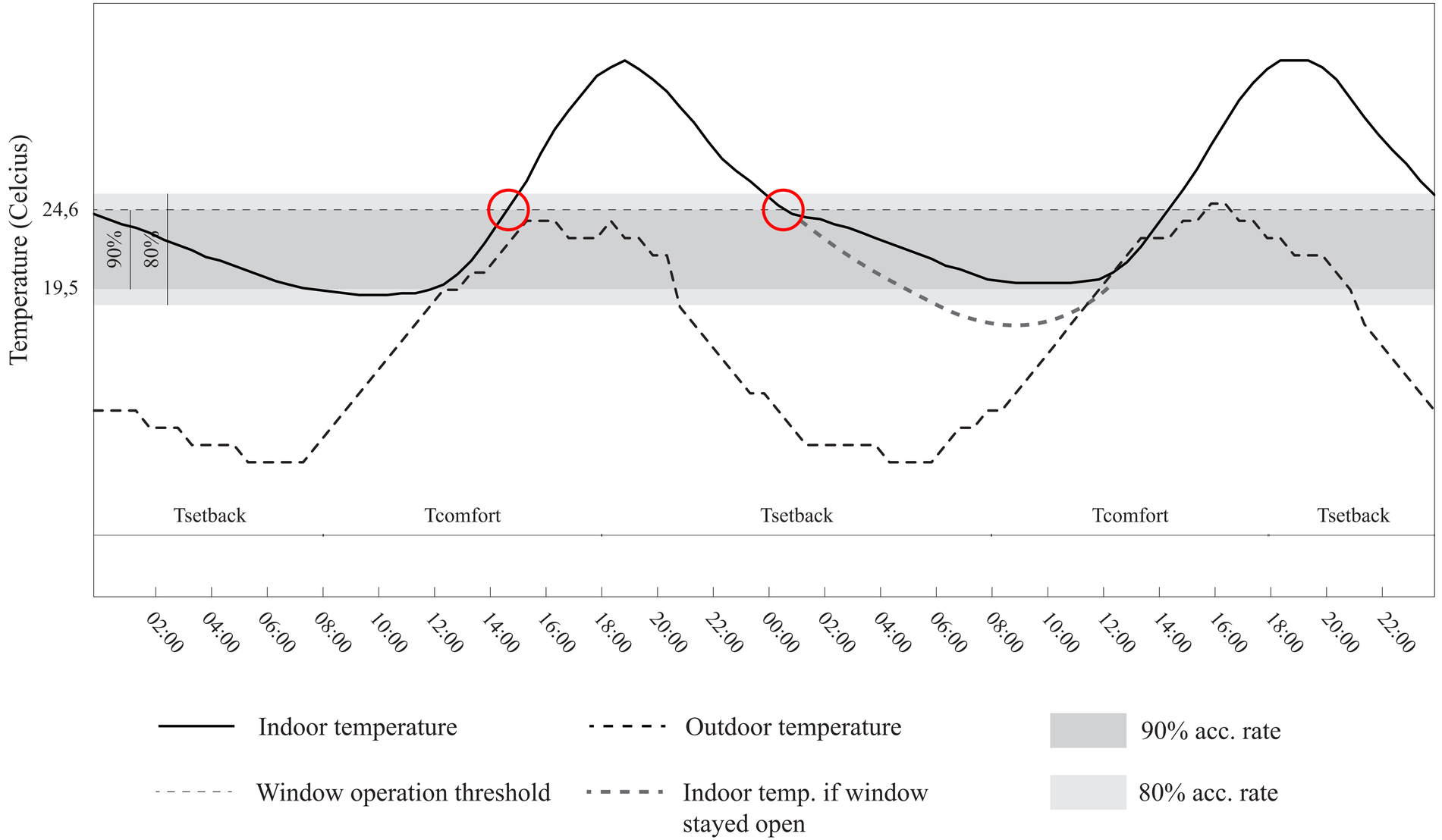
Design

Result



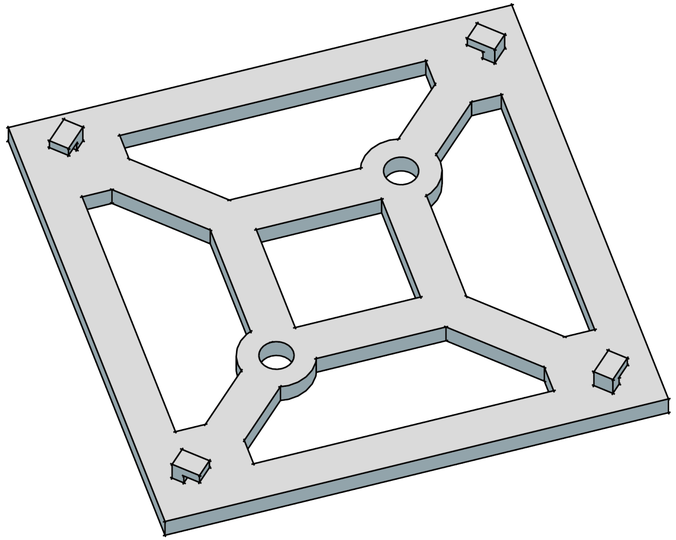
Design

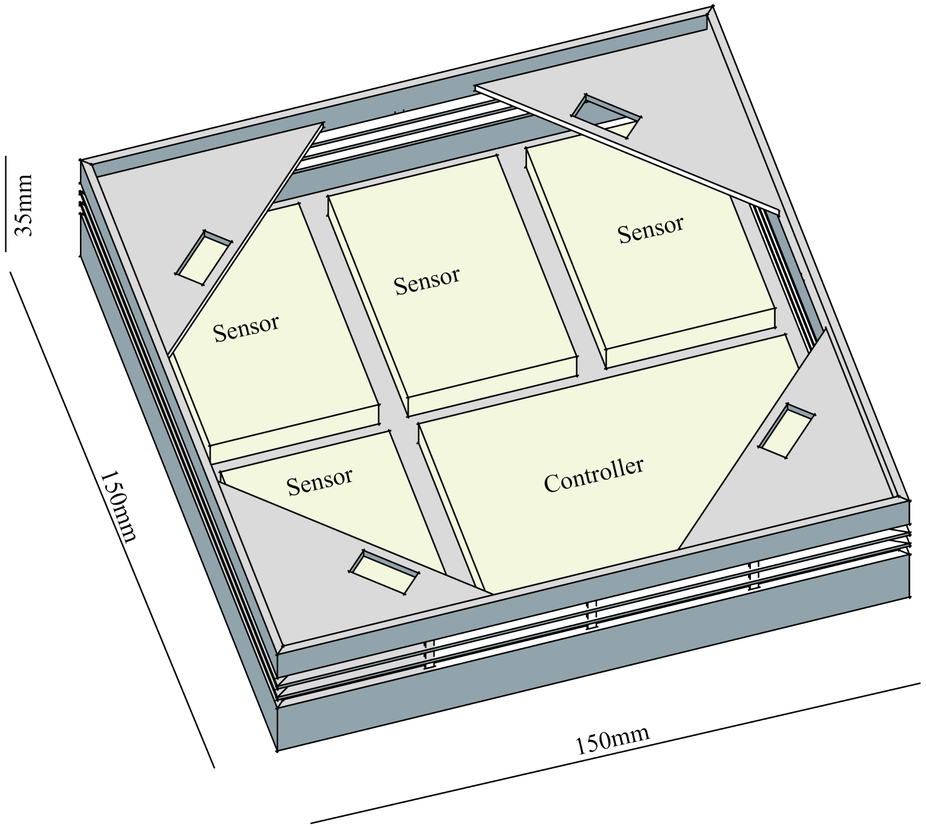
Result



Feasibility

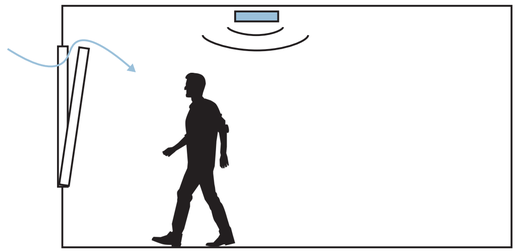
IAQ controller



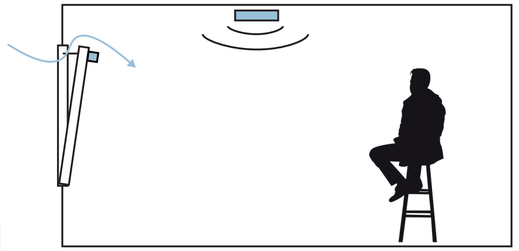


Feasibility

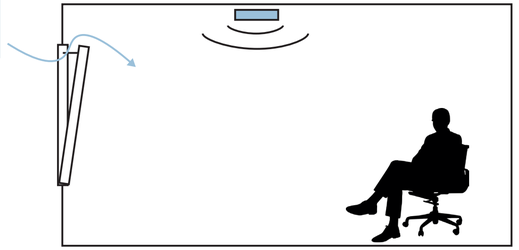
Financial



Building mentor
Investment : 1.365 euro



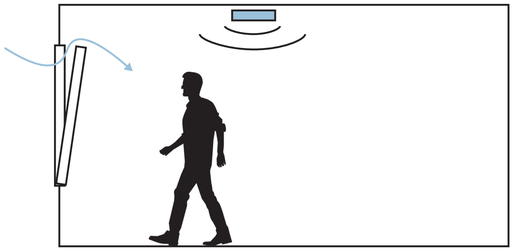
Residence assist
Investment : 2.658 euro



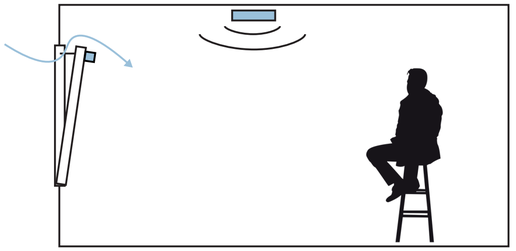
Residence assist deluxe
Investment : 6.550 euro

Feasibility

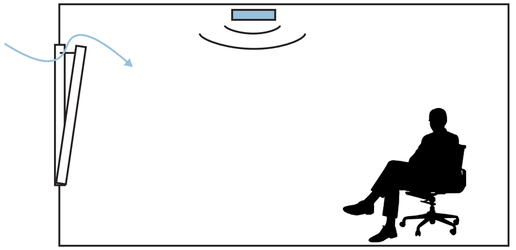
Financial



Building mentor
Investment : 1.365 euro



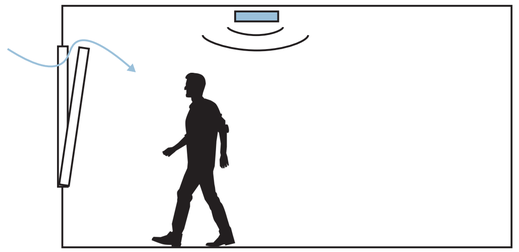
Residence assist
Investment : ~~2.658~~ euro 1.858 euro



Residence assist deluxe
Investment : ~~6.550~~ euro 5.750 euro

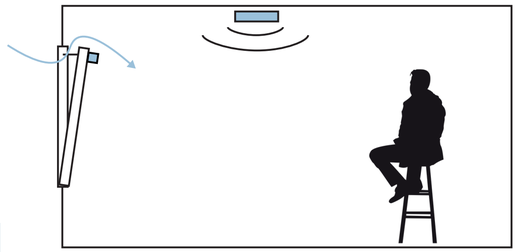
Feasibility

Financial



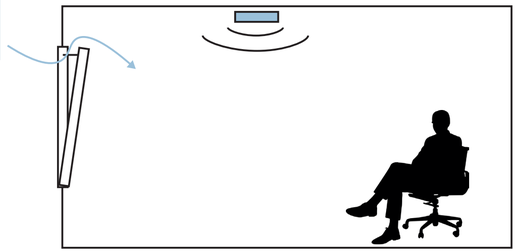
Building mentor
Investment : 1.365 euro

Payback period of 3 years



Residence assist
Investment : ~~2.658~~ euro 1.858 euro

Payback period of 6 years



Residence assist deluxe
Investment : ~~6.550~~ euro 5.750 euro

Payback period of 22 years

Feasibility
Comparison

Demand driven mechnical ventilation
Investment : 12.850 euro

Strength

Active pressure, doesn't rely on outdoor conditions
Can ventilate rooms that are not adjecent to a window
No acoustical pollution from an outdoor source
Can be combined with heat recovery
Filter can be installed

Weakness

Loss of indoor space
Noisy
Electricity usage during operation
Accumulation of pollutants in the system
Prone to user error

(Itho Daalderop, n.d.)
(Bouwkostenonline, n.d.)

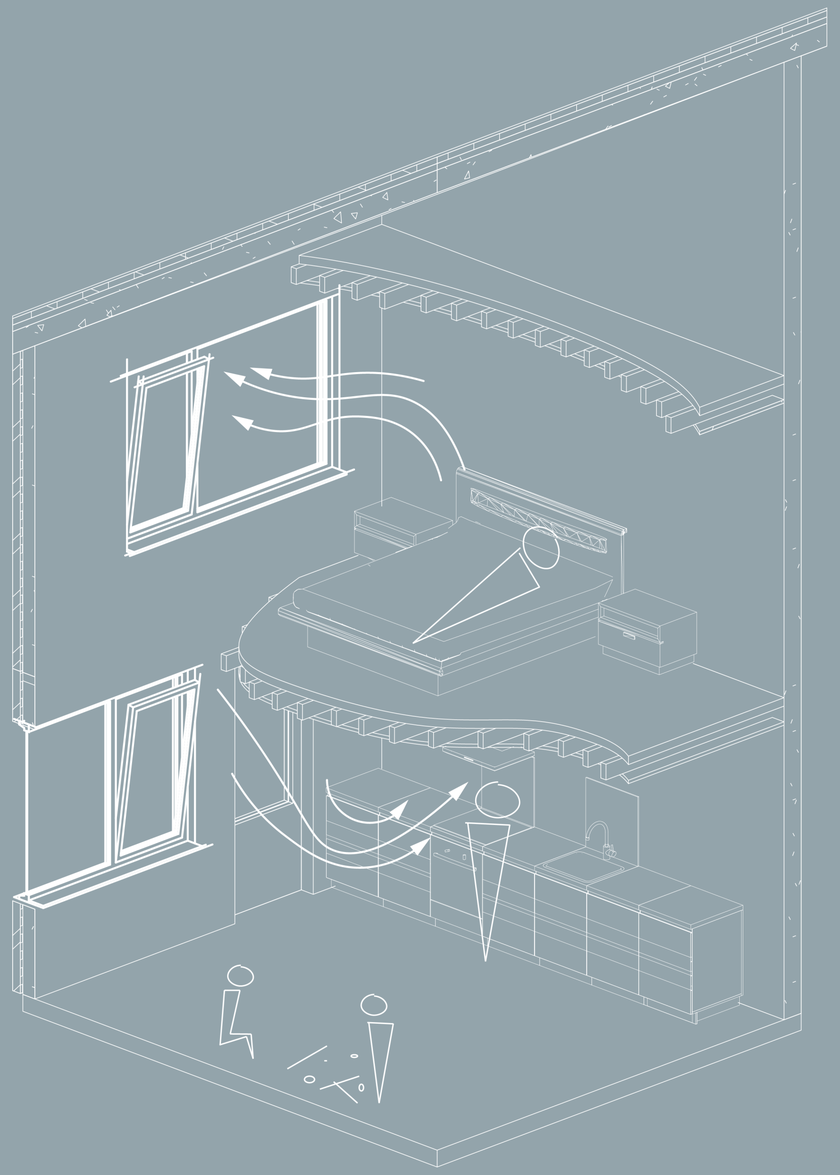
Conclusion

Contributes to thermal comfort and a better air quality

Reduces the effect of user behavior on the final energy demand

Further development on the acceptability and actuators

Boundry conditions



AXA HOME SECURITY

NETATMO

AirTeq.eu
Online monitoring

SCHÜCO
Partner