Urban Home Ventilation

Webinar 6-13-19 May 2020

Date	Theme:
Webinar 6th May:	Kitchen ventilation
Webinar 13th May:	Ventilation requirements, trends and thermal comfort
Webinar 19th May:	Moisture control

Urban Home Ventilation — **Webinar** 6-13-19 May 2020

Webinar 6 May

Theme 1: Kitchen ventilation

15:00	Welcome Chair: Kari Thunshelle, SINTEF
15:05	Documentation of cooker hood performance, a laboratory prespective *Svein Ruud, RISE, Sweden*
15:25	Extract cooker hoods – possibilities and challenges *Haavard Augensen, Røros Metall, Norway*
15:40	Recirculationg cocker hoods – possibilities and challenges *Martin Oberhomburg/Reinhard Wiedenmann, BSGH, Germany*
15:55	Experiences from assessing in-situ effectiveness of cooker hoods *Iain Walker, LBNL, USA*
16:10 - 16:30	*Q&A poll* *Workshop discussion* *Moderator: Peter Schild, OsloMet*

Webinar 13 May

Theme 2: Ventilation requirements, quality, and trends

15:00	Welcome Chair: Kari Thunshelle, SINTEF
15:05	Ventilation and IAQ in Nordic countries – Status, trends and opportunities *Kari Thunshelle, SINTEF, Norway*
15:25	A developer's perspective on urban home ventilation issues *Ole Petter Haugen, Selvaag Bolig, Norway*
15:45	nZEB temperature zoning – "Fresh" bedrooms and a warm living room *Laurent Georges, NTNU, Norway* *Q&A poll*
16:05 -16:30	*Workshop discussion* *Moderator: Peter Schild, OsloMet*

Webinar 19 May

THEME 3: Moisture control

15:00	Welcome Chair: Kari Thunshelle, SINTEF
15:05	Strategies for avoiding too high or too low relative humidity in dwellings *Sverre Holøs, SINTEF, Norway*
15:25	Moisture buffering in modern timber constructions *Dimitrios Kraniotis, OsloMet, Norway*
15:45	Understanding moisture recovery in heat/ energy recovery ventilation as the basis for new market solutions *Peng Liu, SINTEF, Norway*
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webinar
2020. 05.13

Urban Home Ventilation

Part 2: Ventilation requirements, trends and thermal comfort

- 15:00 | **Welcome**, *Kari Thunshelle, SINTEF*
- 15:05 | **Ventilation and IAQ in Nordic countries – Status, trends and opportunities**,
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  Laurent Georges, NTNU, Norway
- 16:05 | **Q&A poll & Workshop discussion**, *Peter Schild, OsloMet*
- 16:30 | **End of webinar**

webinar
2020. 05.06

Urban Home Ventilation

Part 2: Ventilation requirements, trends and thermal comfort

Speakers

Kari Thunshelle
(SINTEF, NO)

Ole Petter Haugen
(Selvaag Bolig, NO)

Laurent Georges
(NTNU, NO)

Moderator

Peter Schild
(OsloMet, NO)

Webinar management

Maria Kapsalaki
(INIVE, BE)

Valérie Leprince
(INIVE, BE)

webinar
2020. 05.06

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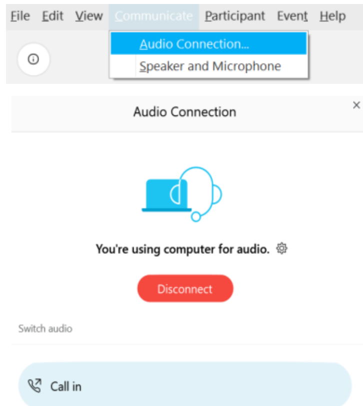

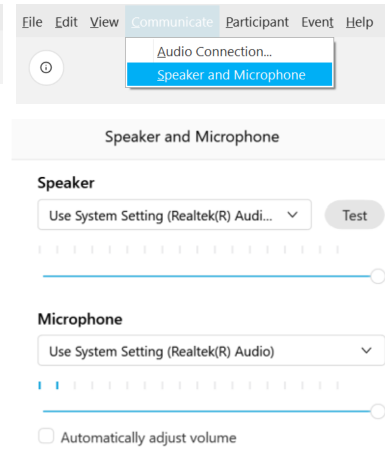

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2020. 05.06

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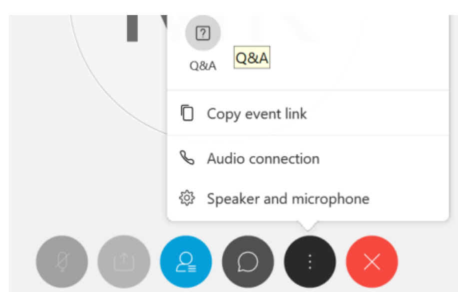
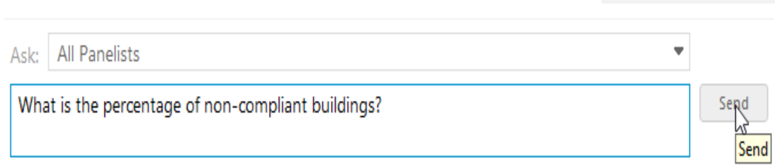


Select **All Panelists** | Type your question | Click on Send



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Urban Home Ventilation

Webinar 6-13-19 May 2020

NOTES:

- The webinar presentations will be recorded and published at http://aivc.org/resources/collection-publications/events-recordings within a couple of weeks, along with the presentation slides.
- Short Q&A Poll before workshop discussion
- After the end of the webinar you will be redirected to our post event survey. Your feedback is valuable so please take some minutes of your time to fill it in.

Organized by www.aivc.org www.sintef.no www.oslomet.no/

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7

SINTEF

70 years
1950-2020

Technology for a better society

8

SINTEF AIVC OSLOMET

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AIVC SINTEF OSLOMET

webinar
2020. 05.13

Upcoming webinar (Urban Home Ventilation part 3)

- Tuesday May 19th 15:00-16:30 (CET) | **Moisture Control**

Registration links can be found at:
www.aivc.org &
https://www.sintef.no/community/kurs-og-konferanser/

Register now!

SINTEF

webinar
2020. 05.13

Webinar on May 6th,2020 (Urban Home Ventilation part 1: Kitchen Ventilation)

- **More than 230 people attended**
- **Recordings now available at:** https://www.aivc.org/resources/collection-publications/events-recordings

SINTEF

SINTEF

70 years
1950-2020

Technology for a better society

AIVC (Air Infiltration & Ventilation Centre)

-IEA information centre on energy efficient ventilation

- Events
  - Organization of **CONFERENCES** & **WORKSHOPS** (typically an annal conference in autumn and a workshop in spring)
  - Organization of **WEBINARS**
- Publications (all free available)
  - Ventilation Information Papers (**VIP**)
  - Technical Notes (**TN**)
  - Contributed Reports (**CR**)
  - Conference & Workshop **PROCEEDINGS**
  - **NEWSLETTERS** in collaboration with venticool and TightVent
  - …
- **AIRBASE**

AIRBASE Click here for searching in a database of 22707 publications with 16232 pdf documents

VENTILATION AND IAQ IN NORDIC COUNTRIES

STATUS, TRENDS AND OPPORTUNITIES

Kari Thunshelle

Senior Researcher, SINTEF

Kari.Thunshelle@sintef.no

Urban development

- Energy efficient buildings and neighbourhoods
- Sustainability
- Urban homes – near public transportation and main roads (air quality and noise)
- Taller and compact

Ill.: Headspin

Home

- New residential buildings are mostly apartment buildings
- Smaller apartments
  2-rooms, 3 rooms, studio, but fewer m^2
- Flexibility and new layouts

3

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The Scandinavian way

Cold climate

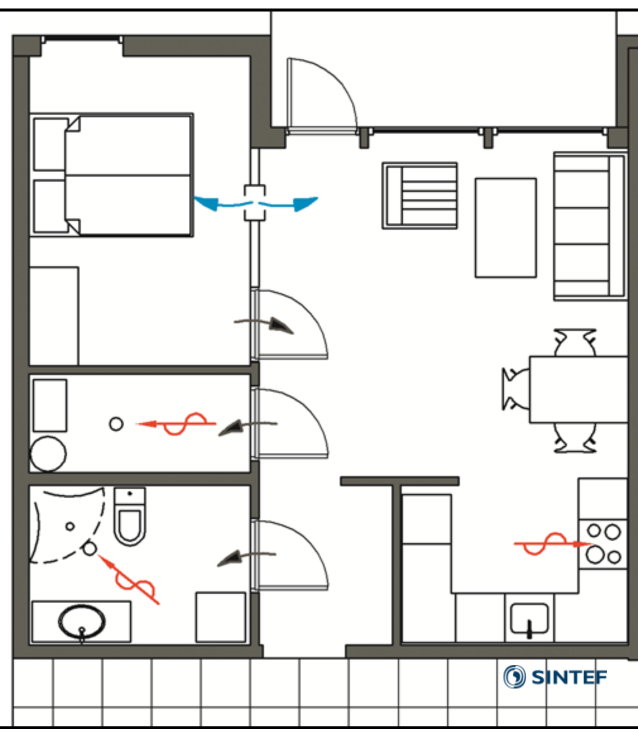
Well insulated buildings (nearly Passive house level)

Low infiltration (0,6 h^{-1} at 50Pa)

Balanced ventilation with efficient heat recovery. (>80%)

No cooling, only shading

No storage room



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Requirements

General: remove moisture, odour, pollutants

NO- 1,2 m^3/h pr m2 (0,33 l/s) average, minimum 0,7 m3/h pr m^2 (TEK17)

26 m^3/h per person in bedroom

DK – 0,3 l/s pr m^2 (BR 2018)

S – 0,35 l/s pr m^2 in use, minimum 0,1 l/s pr m^2 empty (Boverket, BFS 2011:6 with corrections) + R1

	NO-Basic	NO-Forced	DK general
Kitchen	36 m^3/h (10 l/s)	108 m^3/h (30 l/s)	20 l/s
Bathroom	54 m^3/h (15 l/s)	108 m^3/h (30 l/s)	15 l/s
Toilet	36 m^3/h (15 l/s)	36 m^3/h (0 l/s)	10 l/s

Too high ventilation rates for small apartments?

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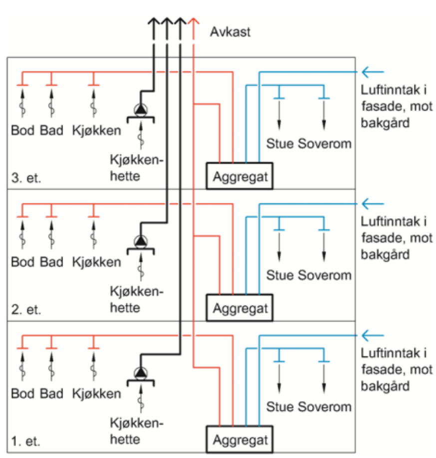
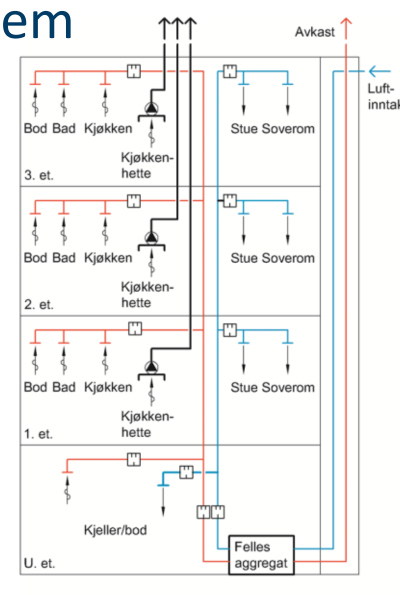
Decentralised vs centralised system





Type of ventilation system and ownership

- Ownership often the reason behind type of system
- Decentralised preferred for control of IAQ
- Maintenance – access, understanding, time/ability. Tenant/owner

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Kitchen ventilation

- Hot plate
- only some gas burners
- Placing of hood
- Capture efficiency
- Window and door?

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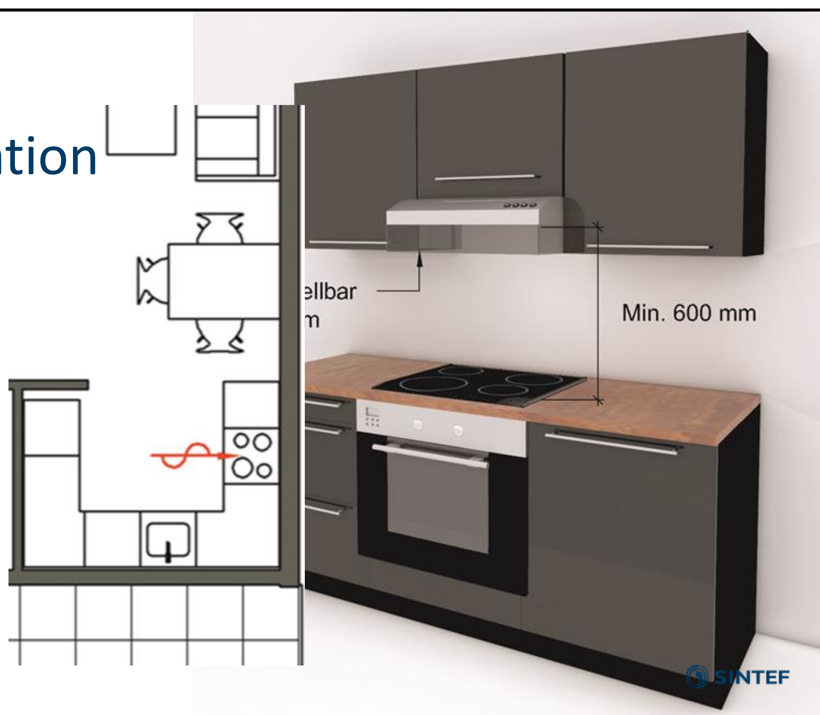


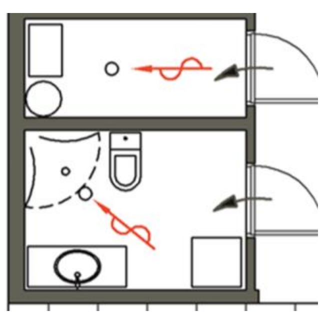
Trends

- Kitchen island + open space living
- High airflow rates
- Downdraft
- Recirculation – odour, not moisture
- Noise
- Make up air?
- User profiles? Students, family, elderly
- One room apartments vs 4 rooms

Ill: Norema & Røros metall

Moisture

- Bathrooms without windows
  -forced ventilation?
- Cold climate
- Small apartments
- High ventilation rates
- Buffering
- Regeneration



Indoor temperature

- 22-24°C
- Open window at night?
- Featherbed cover
- Bedroom?
- Cooling?

11

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Ventilation rate and strategy adapted to apartment size and assumed user profile?

- Define architypes of urban dwellings
- User profiles according to size/type
- Adapted ventilation strategies

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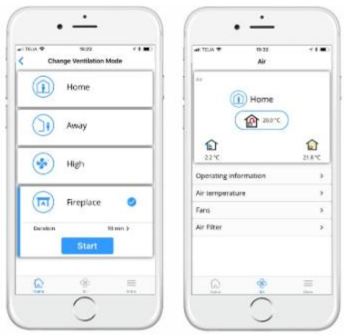
App, Cloud and BMS



Reduction of power peaks

- Maximum installed power

Healthy Energy-efficient Urban Home Ventilation.

Norwegian research project 2020-2024

WP1: Types and user profiles of urban dwellings

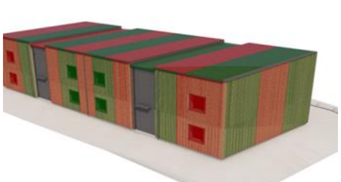
WP2: Advanced residential exposure studies

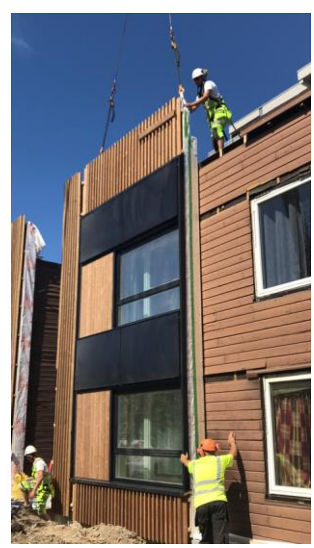
WP3: Moisture, ventilation and building physics

WP4: Assessment and recommendation

ZEN? Deep renovation is necessary

- Prefabrication.
- Integrated ventilation and RES
- Modules with technical room
- https://4rineu.eu/demo-oslo/





SINTEF

70 år
1950-2020

Teknologi for et bedre samfunn

Kari.Thunshelle@sintef.no

A developer's perspectives on Urban Home Ventilation

Oslo, May 13th 2020

Ole Petter Haugen

SELVAAG BOLIG

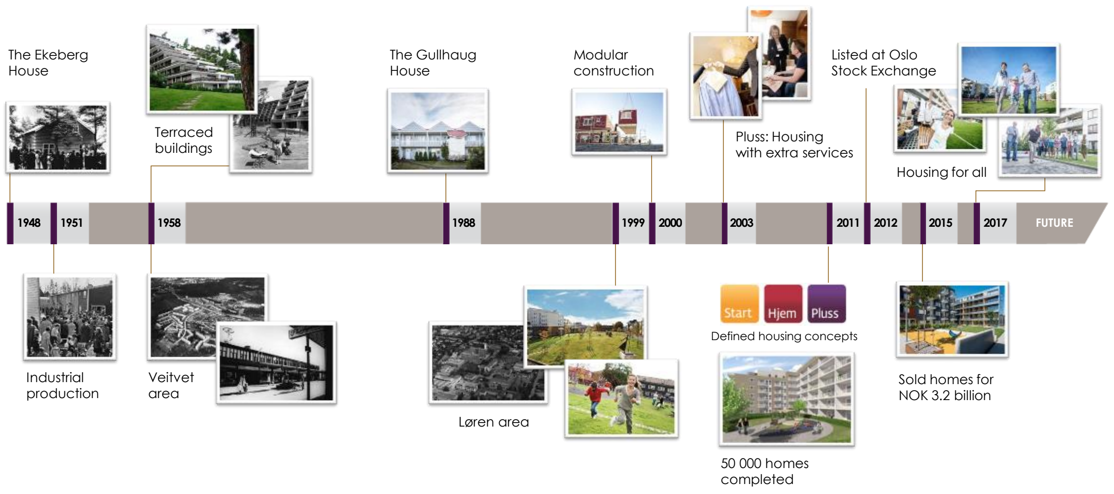
1

Long-term housing development

- **Nearly 60 000 homes** over the last 70 years
- **Urban development**, large projects in fast growing urban regions
- **Housing for all**, competitive housing offering

2

Selvaag Bolig is a story about development



A story about affordable homes for everyone

- Selvaag has always challenged regulations and established standards in order to fulfill thousand of families dream of owning their own home.
- Wright now are the challenged urban sustainable development.
- How do we provide energy efficient indoor climate in new homes located on polluted noisy transportation hubs?
- I believe sufficient ventilation must be optimized with energy use for heating, cooling and hot tap water.

Home ventilasjon, changes over time

- Home ventilation has been almost unchanged before use of balanced ventilation
- Until 1985 was the regulation limited to things like
  - Demand of fresh air supply, 150-300 m^3/h, to room with fireplace
  - Livingroom and bedrooms only needed to have a window that could be opened.
  - Ventilation from kitchen was solved with ducts up abode the roof. Fan was first mentioned in 1969.
- Building regulations of 1985 and 1997 only gave functional requirements. Ventilation should ensure proper indoor climate for people in the home. Each room should have ventilation based on its functions. Kitchen, sanitary room and vet rooms should have air exhaust. There was no demand for exhaust fan.
- Use of mechanical ventilations / exhaust fans became more and more common in multifamily houses from the 1970, even though it was not required before regulations in 1997.
- Ventilation openings for inlet of cold outdoor air used to be the most common solution before new energy regulations in 2007, (TEK07).
- Energy regulations gave us balanced ventilation with heat recovery.

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Regulations on residential ventilation in TEK17

- TEK17, §13-2. Ventilation in residential buildings.
  1. Dwellings shall have ventilation witch ensure average fresh air supply of minimum 1,2 $m^3/h{*}m^2$, (used to be a half air changes each hour).
  2. Bedroom shall have a supply of minimum 26 m^3/h for each bed
  3. Rooms without permanent residence shall have a ventilation of minimum 0,7 $m^3/h{*}m^2$
  4. Kitchen, bathroom, toilet and other vet rooms shall have sufficient exhaust
- In new dwellings are the required ventilation obtained with balanced ventilation with a heat exchanger.
- Decreased air change can be obtained by opening windows if that is compatible with outdoor air quality and noise from the surroundings.
- Tomorrows development of new residential areas on transportation hubs will require sufficient ventilation and indoor climate with closed windows due to outdoor air quality and noise.

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Costumers expectations on indoor climate

- Most costumers simply expect that the ventilation system supply fresh air and exhaust polluted air in order to keep a comfortable indoor climate. They don't care about air changes and fresh air amounts.
- In general has the possibility of opening windows been an expectation. Most Norwegian sleep with an open bedroom window.
- We experience a decrease in claims due to limited possibility of cooling the dwelling during summer. Decreased air changes don't help when it's warm outside for a long period
- Costumers expects thermal comfort beyond todays delivery and regulations. They want to adjust the temperature the same way as in their premium cars.
- Tomorrow's costumer will demand energy efficient heating and cooling in their homes.
- We must realize that there is no way around cooling!

SELVAAG BOLIG

Possible future scenarios for home ventilation

- Dwellings in urban areas will need sufficient ventilation without use of open windows.
- In addition to the basic function of ventilation, supply fresh air and exhaust polluted air, will we need heating and cooling in the apartments.
- I believe the ventilation system will be the main system for heating and cooling.
- We must design sustainable energy systems where energy for cooling the air are used to heat tap water.
- Heating with ventilation air are disputed and must be limited.
- Use of district heating for base ventilation heat and hot tap water.
- Peak heating in cold periods solved with electricity.

SELVAAG BOLIG

OPPTRE Energioppgradering av småhus i tre til nesten nullenerginivå

Temperature Zoning in Highly-Insulated Buildings

Colder Bedrooms in Winter with Warm Living Rooms

Laurent Georges and Vegard Heide
Energy and Process Engineering Department, NTNU

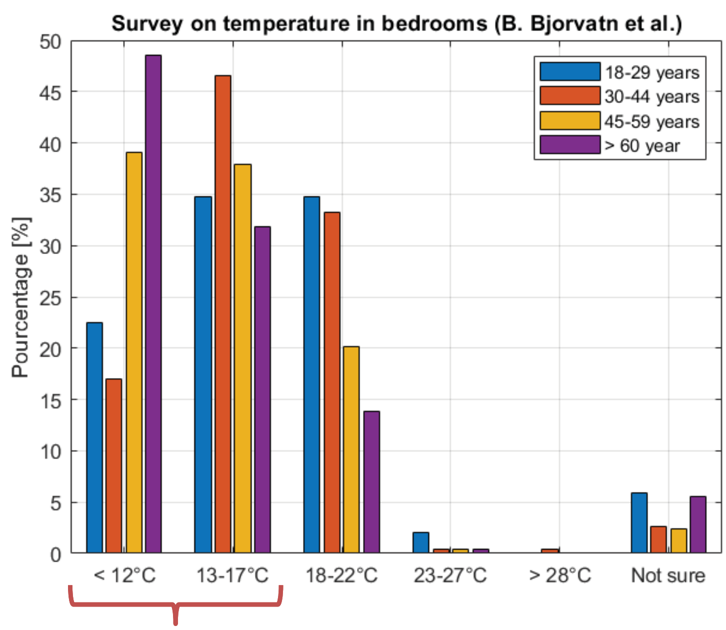
Urban Home Ventilation, AIVC seminar, May 2020, Norway

Norwegian University of Science and Technology

NTNU

Need for Colder Bedrooms in Norway (1)

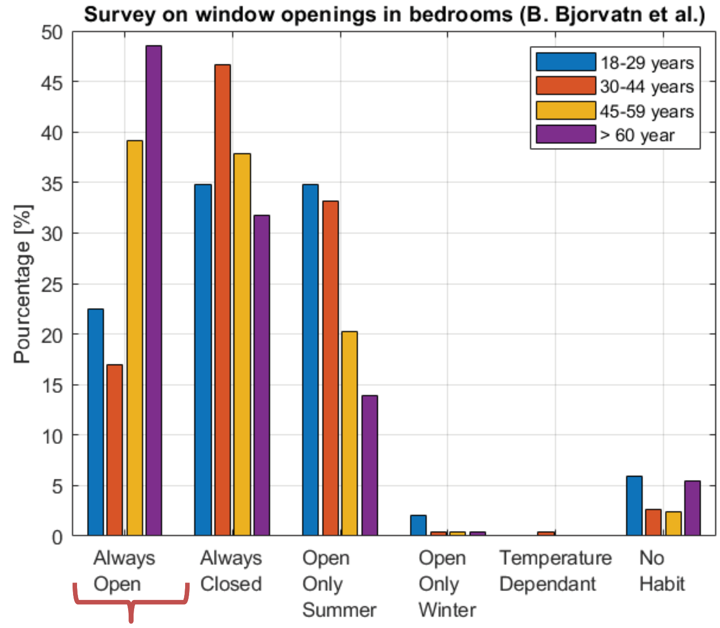
- Without considering a specific building energy performance
- Survey (Bjorvatn et al. 2017)
  - 1001 Norwegians selected randomly
  - 70% with bedroom temperature < 18°C
  - Many with bedroom temperature < 12°C



OPPTRE NTNU

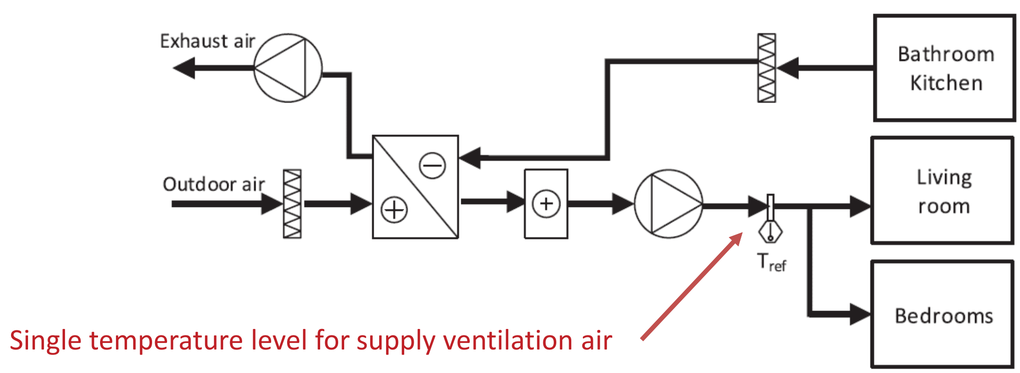
Need for Colder Bedrooms in Norway (2)

- Without considering a specific building energy performance
- Survey (Bjorvatn et al. 2017)
  - 1001 Norwegians selected randomly
  - Many keep bedroom windows always open, especially with age above 45



Temperature Zoning in nZEB (1)

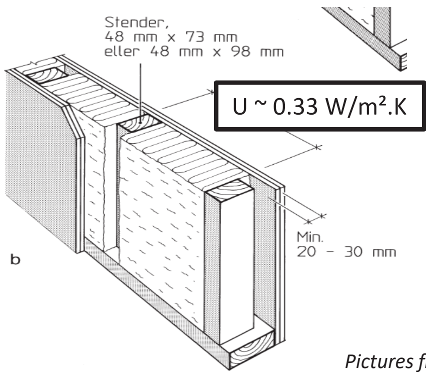
- Limited temperature zoning in highly-insulated building envelopes
  - Highly-insulated external walls and high-performance windows
  - Centralized one-zone balanced mechanical ventilation with efficient heat recovery

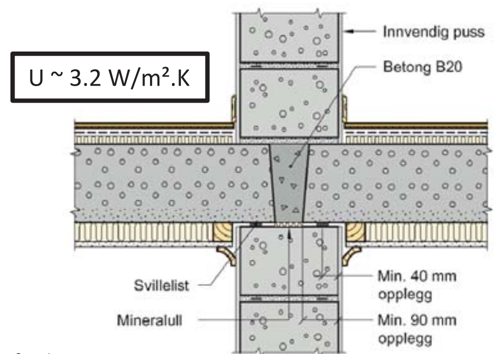


Pictures from Berge et al., Building and Environment 2016

Temperature Zoning in nZEB (2)

- Influence of building construction mode
  - Partition walls insulated in lightweight constructions
  - Positive effect on temperature zoning
  - Many lightweight wooden constructions in Norway





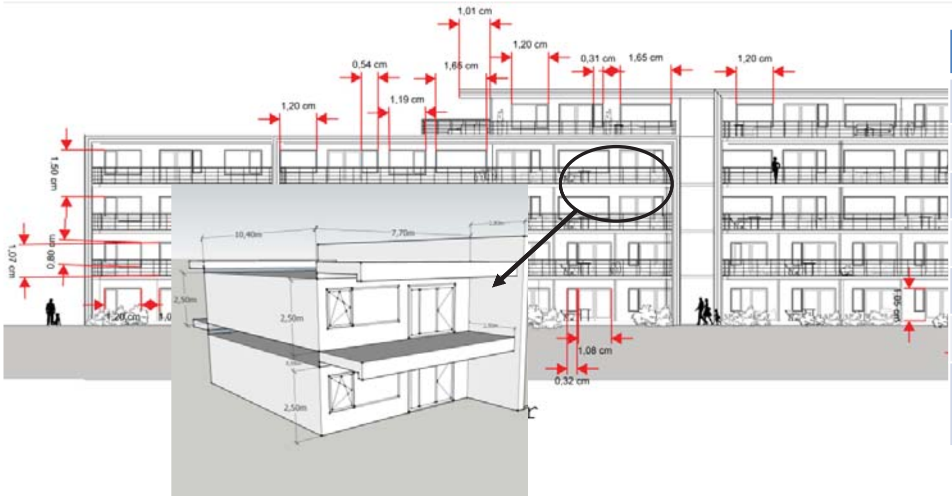
Pictures from SINTEF Byggforskserien

Temperature Zoning in nZEB (3)

- Experience of indoor thermal environment in Norwegian passive houses
  - Based on questionnaires and field measurements
  - ~100 dwellings (Berge et al. 2016, Thomsen et al. 2017)
- Regarding bedrooms
  - Many occupants want colder bedrooms (< 16°C)
  - ~50% occupants open bedroom windows several hours every day during winter time
  - The main motivation is temperature control not IAQ
  - Occupants do not control the supply ventilation air temperature correctly to get colder bedrooms
- Regarding living areas
  - Desired indoor temperature is often between 22°C and 24°C

Temperature Zoning: example apartment (1)

- Two identical apartments from *Miljøbyen Granåsen* project in Trondheim

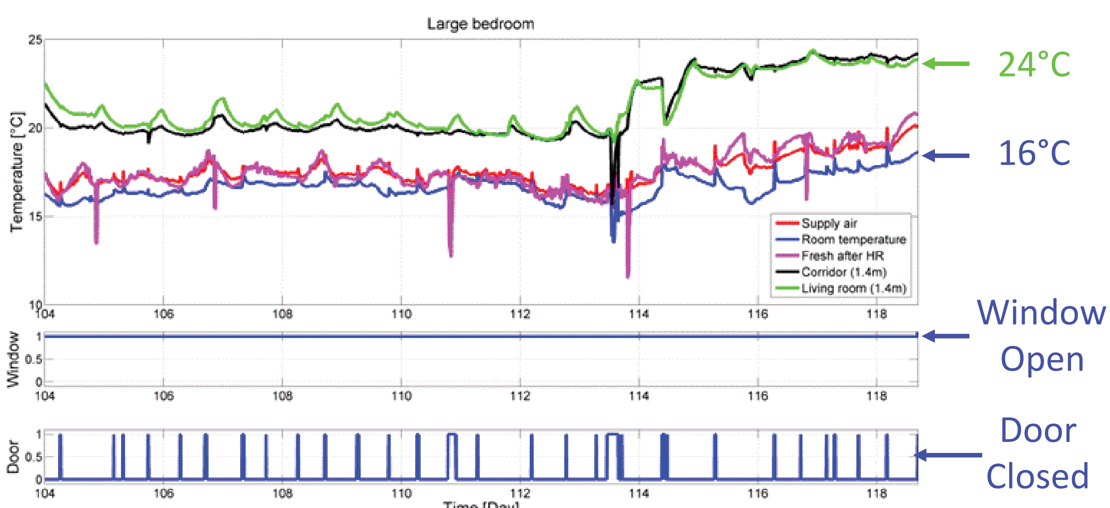


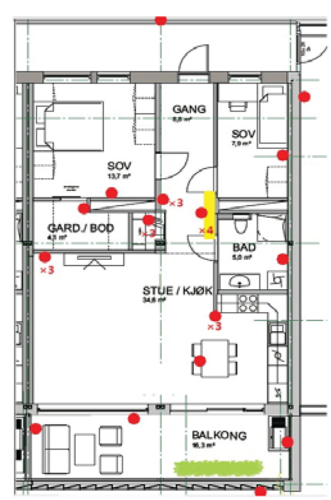
Thermal property	Value
U external walls	0.17 W/m².K
U wall to atrium	0.16 W/m².K
U between flats	0.25 W/m².K
U internal walls	0.49 W/m².K
Thermal bridges	0.02 W/m².K
Infiltration (design)	0.6 ach at 50 Pa
Ventilation CAV (one AHU per flat)	1.5 m³/m².h 85% rated efficiency

Georges et al. 2016

Temperature Zoning: example apartment (2)

- Measurement during two weeks in a passive house apartment

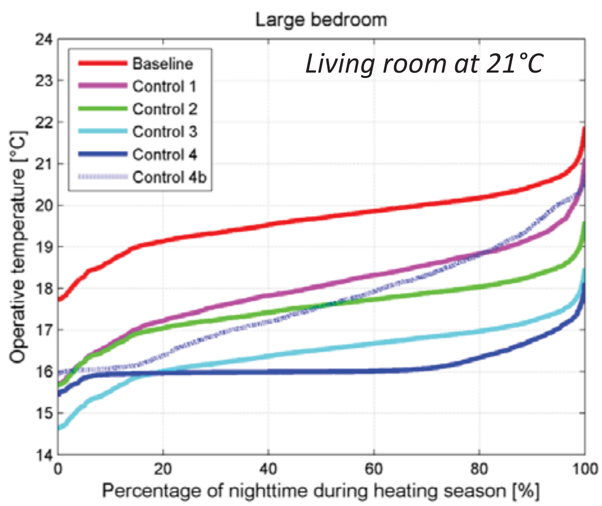


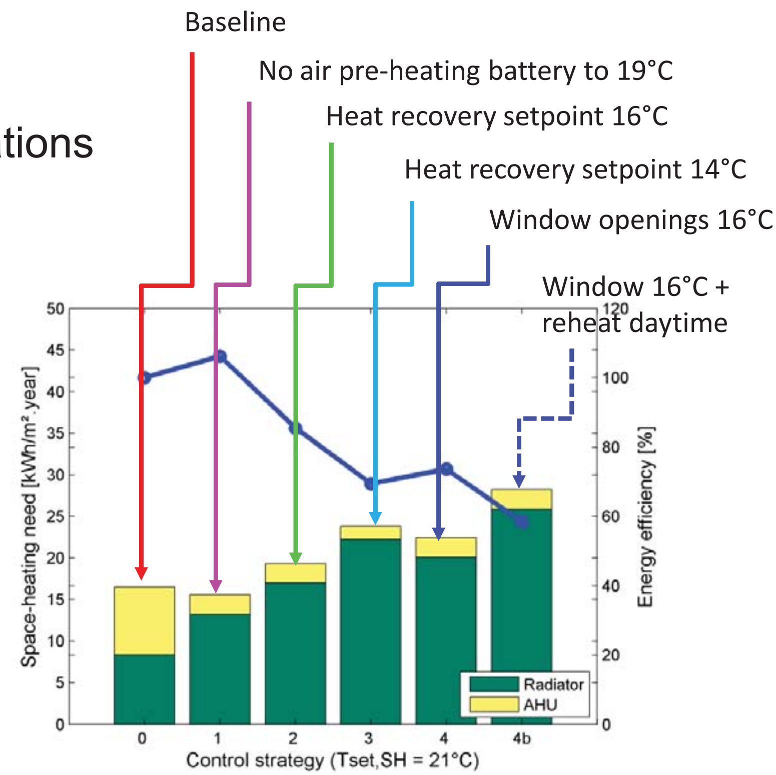


Georges et al. 2016

Is it due to control?

- Based on calibrated dynamic simulations
  - Multi-zone simulations in IDA ICE with embedded ventilation network

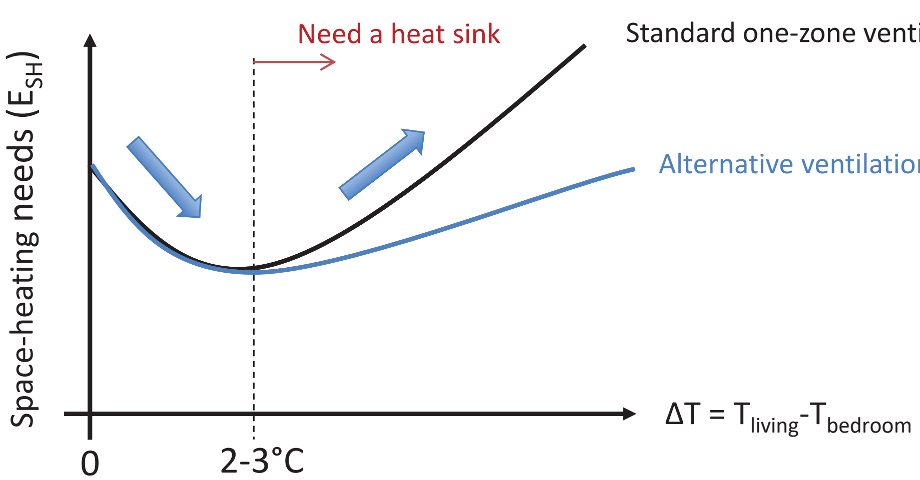




Georges et al. 2016
OPPTRE NTNU

Conclusions for Lightweight Construction

- Based on measurements and simulations
  - Apartment block, terraced and detached houses at Norwegian passive house level



OPPTRE NTNU

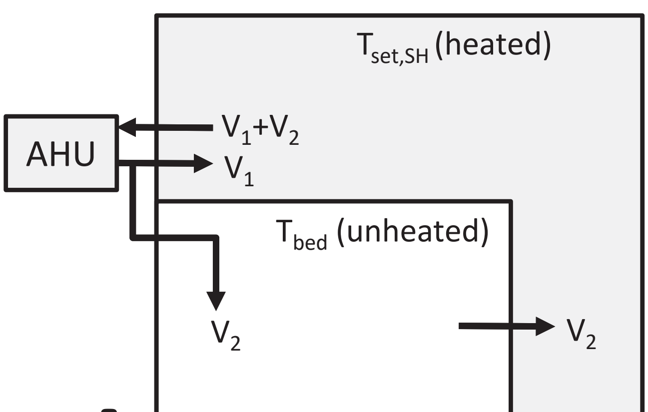
Temperature Zoning: research question

- Research showed that
  - Large temperature zoning leads to significant increase of space-heating needs (ΔE_{SH})
  - Control alone cannot decrease bedroom temperature without large ΔE_{SH}
  - Something should be changed in the building concept, like the ventilation strategy

- How to reduce ΔE_{SH} with large temperature zoning?
  1. Relative importance of ventilation and heat conduction in partition walls?
  2. How alternative ventilation strategies would improve energy efficiency?

Framework of Analysis

- Steady-state heat transfer (P) from heated to unheated rooms



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One zone cascade ventilation

$$P = \underbrace{U_p(T_{set,SH} - T_{bed})}_{\textit{Heat conduction}} + \underbrace{\dot{V}_2 C_p (T_{set,SH} - T_{bed})}_{\textit{Ventilation reheating}}$$

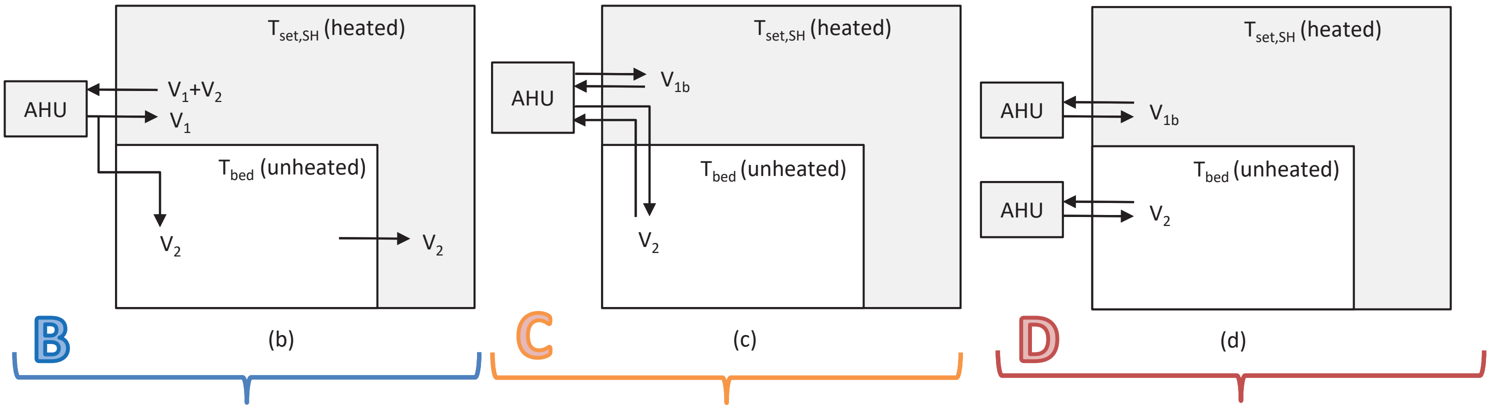
- When open bedroom window, nothing changes for heated zone except

$$\underbrace{T_{bed,open}}_{\text{windows open}} < \underbrace{T_{bed,closed}}_{\text{windows closed}} \Rightarrow \underbrace{P_{open}}_{\text{windows open}} > \underbrace{P_{closed}}_{\text{windows closed}}$$

Georges et al. 2019

Alternative ventilation strategies

- To reduce the ventilation contribution on ΔE



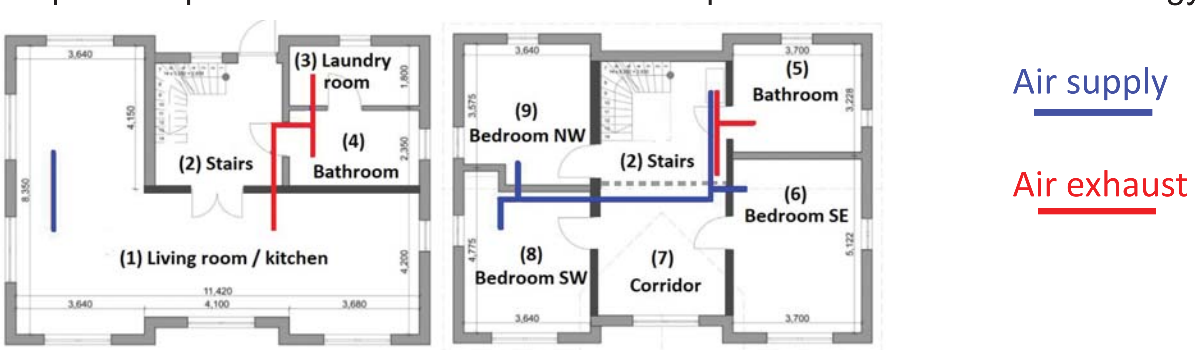
V_2 switched off if bedroom with windows opened

Balanced ventilation in bedrooms

Decentralized ventilation in bedrooms and heated zones

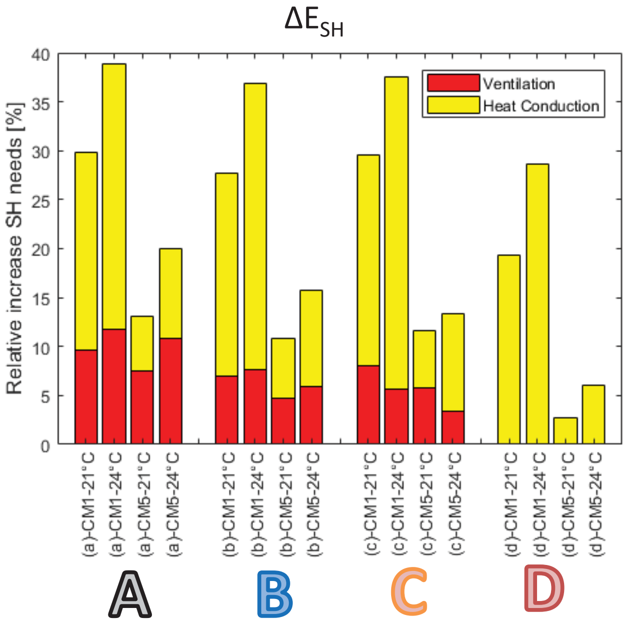
Simulation Case Study

- Detached Passive House
  - 173 m² located in Oslo
  - With different construction modes (lightweight to heavy)
  - Simulated in IDA-ICE with embedded ventilation network
  - CAV with pre-accepted airflow rates from TEK17 adapted for each ventilation strategy



(a) First floor *Cascade ventilation* (b) Second floor

Steady-State Analysis



- Setup
  - Outdoor temperature selected to give typical temperature zoning
  - Heavy-weight (CM1) and Lightweight (CM5) constructions
  - Two different set-point temperature in living areas (21 and 24°C)
  - Increase of space-heating needs analyzed ΔE_{SH} due to window opening in bedrooms
- Conclusions (1)
  - Heat conduction > ventilation effect in heavy-weight buildings (CM1)
  - Heat conduction ≈ ventilation effect in light-weight construction (CM5)

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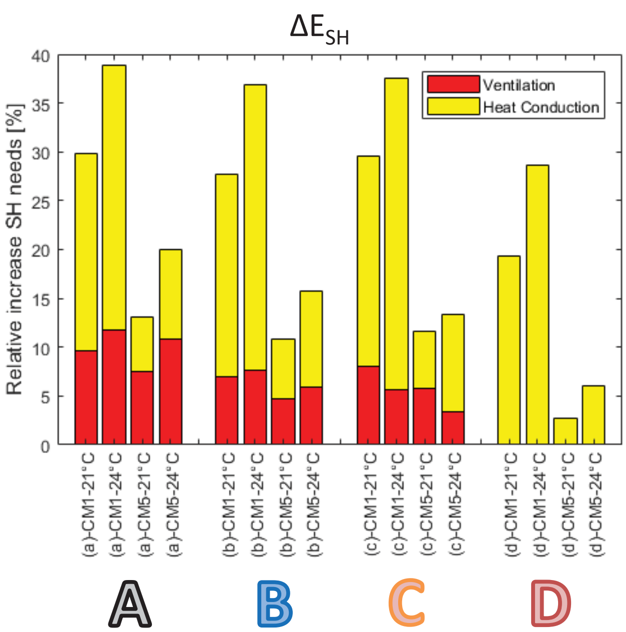
Steady-State Analysis



- Conclusions (2)
  - Moderate reduction of ventilation effect for strategies (B) and (C) compared to (A)
  - No ventilation effect with strategy (D)
  - Heat conduction part left almost unchanged between A, B, C and D

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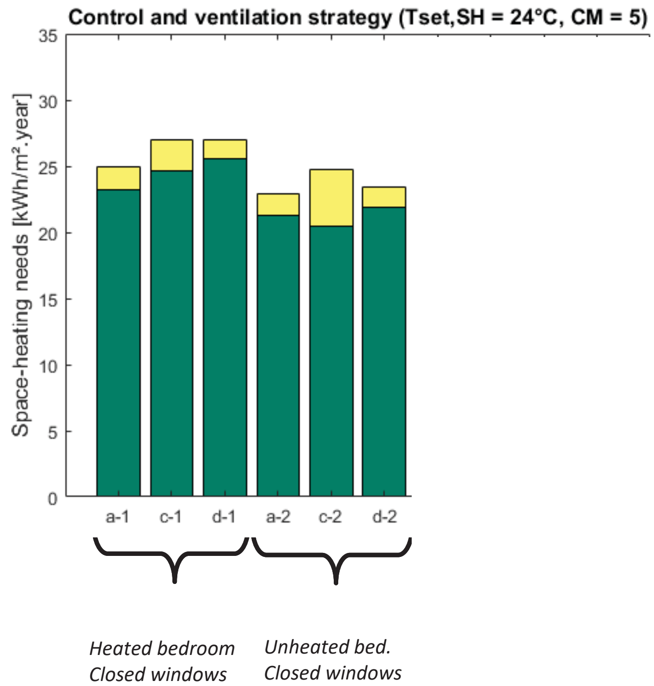
Yearly Dynamic Simulation

- Setup
  - Lightweight construction (CM5)
  - Set-point temperature in living area of 24°C
  - Compare different strategies for control
- Conclusion with closed bedroom windows
  - Higher ventilation airflow rates in (C and D) compared to A (from pre-accepted building code TEK17)
  - Slightly higher space-heating needs without cascade ventilation (C and D)



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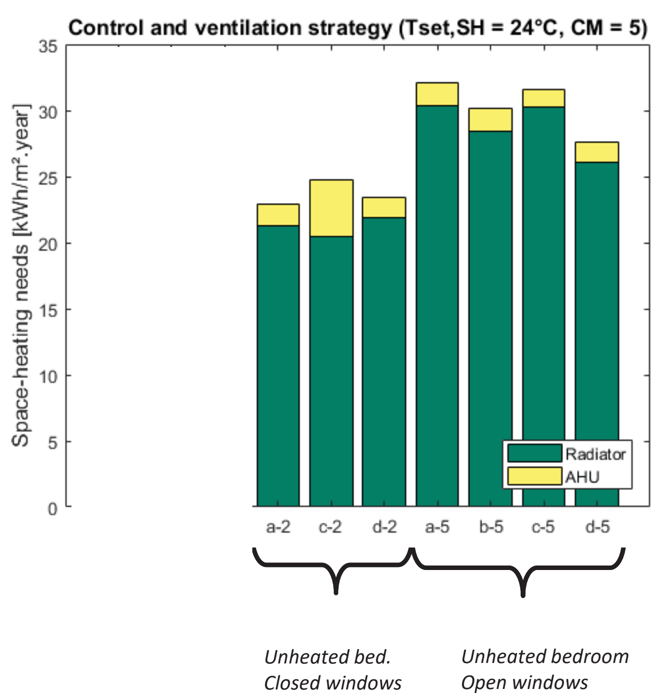
Yearly Dynamic Simulation

- Conclusions open bedroom windows
  - Always an increase of space-heating needs
  - Slightly lower increase for (B) and (C) than (A)
  - Lower increase for decentralized (D) than (A)



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Conclusions (1)

- Highly-insulated building with one-zone balanced mechanical ventilation
- Need to improve energy efficiency with large temperature zoning (> 3°C)
  - Simulations show that it is not a question of control
  - Need to change the building concept
- Important remarks
  - *Buffer zone* with intermediate temperature level effective for zoning
  - Results can be very different with less insulated partition walls (e.g. heavy-weight buildings)

Conclusions (2)

- Regarding the increase of space-heating needs with large zoning (ΔE_{SH})
- Question 1:
  - Heat conduction dominant in heavyweight buildings (non-insulated partition walls)
  - Effect heat conduction and ventilation have the same magnitude for lightweight buildings
  - Ventilation strategy cannot solve the problem alone
- Question 2:
  - Ventilation contribution can be moderately reduced by shutting down supply air in bedrooms of mechanical ventilation when bedroom windows are opened (strategy B)
  - Ventilation contribution can be moderately reduced by balancing airflows in bedrooms (strategy C, here still with a one single supply air temperature)
  - Ventilation contribution can be significantly reduced by decentralized ventilation (D)

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Thank you for your attention!

Laurent Georges and Vegard Heide

laurent.georges@ntnu.no, vegard.heide@ntnu.no

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Case Study

- Control strategies changing set-points for
  - Heated zones, AHU heating coil, bedrooms, window and door opening

Cases	Living areas $T_{set,SH}$	AHU $T_{set,AH}$	Bedrooms $T_{set,bed}$	Windows Schedule	Windows $T_{set,win}$	Door Schedule
1	21 or 24°C	$T_{set,SH}$-3	$T_{set,SH}$	Closed	-	Closed
2	21 or 24°C	$T_{set,SH}$-3	None	Closed	-	Closed
3	21 or 24°C	16°C	None	Closed	-	Closed
4	21 or 24°C	14°C	None	Closed	-	Closed
5	21 or 24°C	$T_{set,SH}$-3	None	Open (Night)	16°C	Closed
6	21 or 24°C	16°C	None	Open (Night)	16°C	Closed
7	21 or 24°C	14°C	None	Open (Night)	16°C	Closed
8	21 or 24°C	$T_{set,SH}$-3	None	Open (Night)	16°C	Open (Day)

Nominal Ventilation Airflow Rates

- Pre-accepted values from building code TEK17, leading design criteria:
  - Supply airflow in bedrooms in cascade ventilation
  - Exhaust airflow in "wet" rooms without cascade ventilation

Table 2. Ventilation airflow rates for the different ventilation strategies [12].

Zone	Room	With cascade (baseline)		Without cascade**	
		Supply [m^3/h]	Return [m^3/h]	Supply [m^3/h]	Return [m^3/h]
1	Kitchen and Living	104	40	126	36
2	Stairs	0	0	0	0
3	Technical/Laundry	0	40	0	36
4	Bathroom 1st floor	0	64	0	54
5	Bathroom 2nd floor	0	64	0	54
6	Bedroom SE	52	0	52	52
7	Corridor 2nd floor	0*	0	54	0
8	Bedroom SW	26	0	26	26
9	Bedroom NW	26	0	26	26
Total		208	208	284	284

* In strategy (b), this airflow is 104 m^3/h if the supply ventilation air in bedrooms is stopped.
** This corresponds to the strategy (c) and decentralized ventilation (d).