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The importance of indoor air quality and some Danish school examples

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Agenda

Indoor air quality

- Health, absence rates, performance (with slides of Pawel Wargocki)

Examples of Danish school buildings

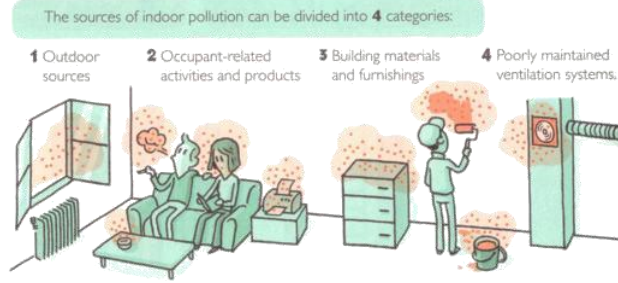
- Vibeengen school & Nordstjerne School

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Components in the indoor air

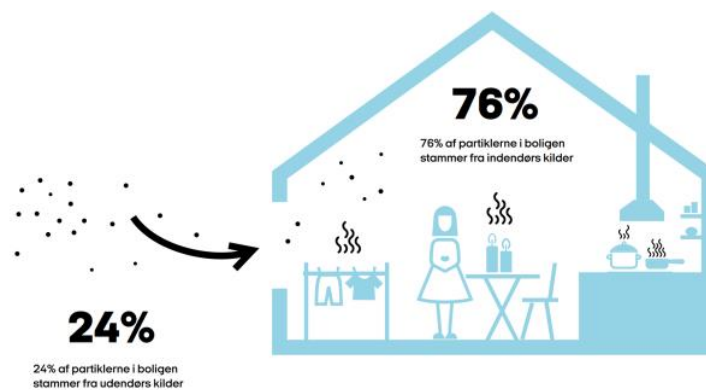
- Dust, pollen, pollen, VOC's, radon, fungal spores, smoke, ultra-fine particles

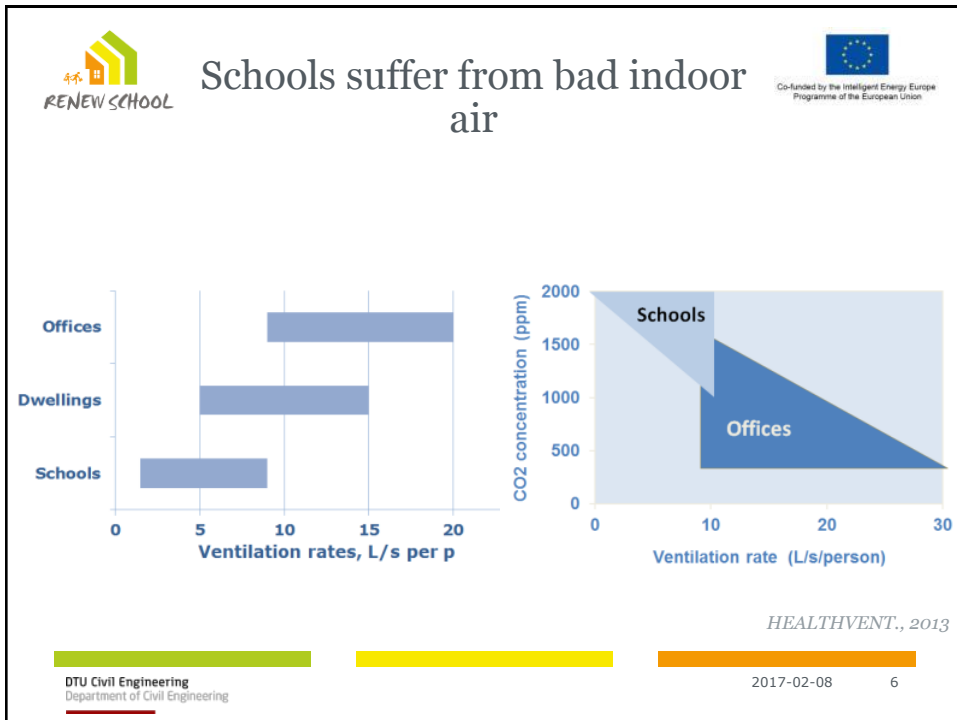




VOC's alone are counted in thousands:

- acrolein, formaldehyde, benzene, hexachlorobutadiene, acetaldehyde, 1,3-butadiene, benzyl chloride, 1,4-dichlorobenzene, carbon tetrachloride, acrylonitrile, vinyl chloride, ozone, carbon monoxide and more...

The origin of ultra-fine particles






 **IAQ in schools is important** 
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- 20% of EU's population go to school
- Pupils spend 20% of their time in schools
- Children must attend school; they can not absent themselves or find another school
- The work that children are obliged to perform in schools is not optional and almost always new
- Children have far fewer ways of registering complaints
- The effects of IAQ on children are likely to be more marked than for adults as children are more vulnerable and their bodies are still growing

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School environment is special




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- Children (pupils) and adults (teachers and other personnel)
- Occupancy is higher in classrooms than in other buildings (offices/dwellings)
- Teaching is carried out in groups (classes) with low area/volume per person
- There should be as least as possible distraction during teaching




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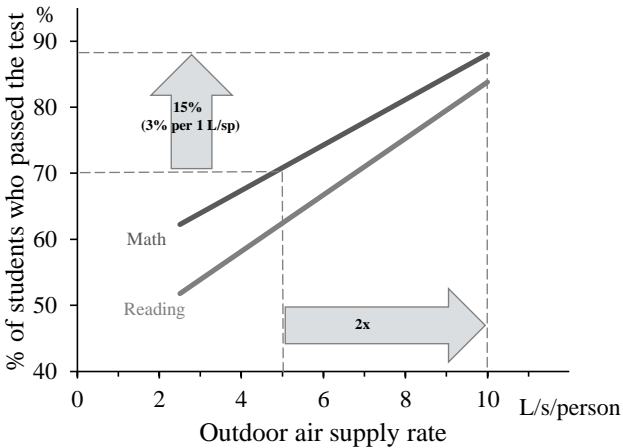
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Standardized tests – math and reading



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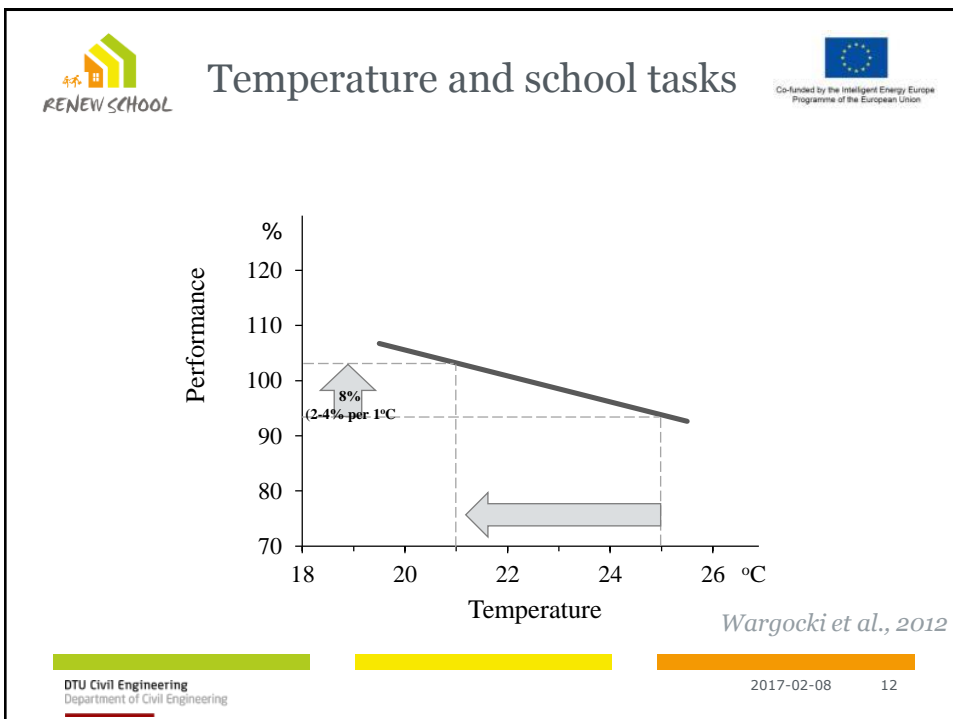
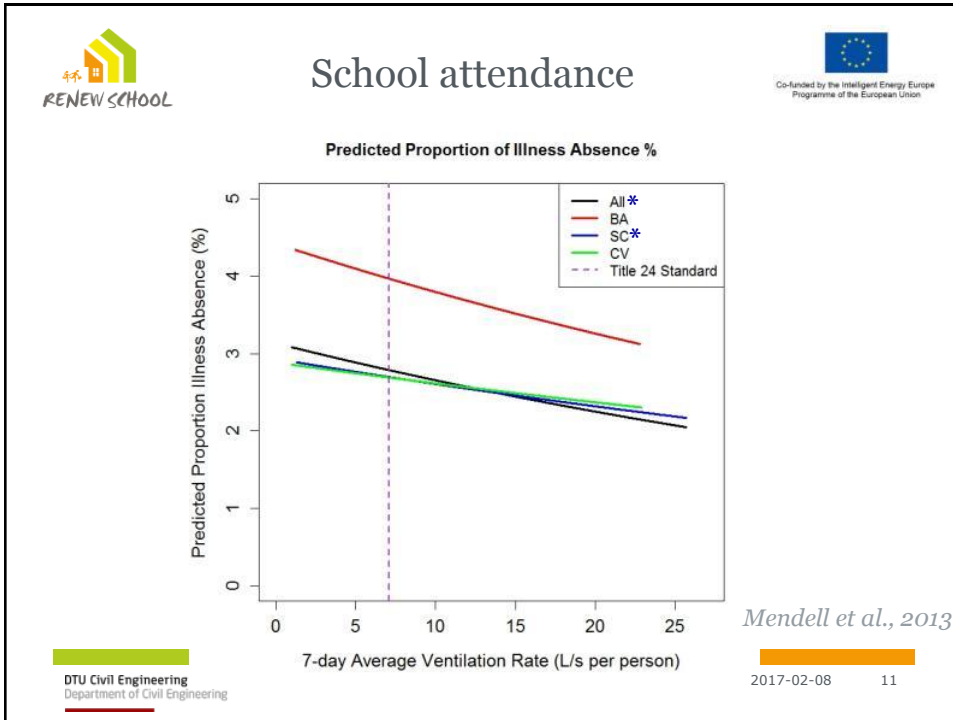


Haverinen-Shaughnessy et al., 2013



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Noise, daylight and school work



- Text comprehension and memory were negatively affected by increased episodic noise from airplanes; the effect was linear
- There were no strong effects of the continuous traffic noise (cars) on the performance of schoolwork – cognitive tasks, only episodic memory was slightly affected
- School grades in elementary schools were improved by 21% for pupils in classes with much daylight compared with classes with least daylight



Summing up



- 1 L/s per pupil higher ventilation rate
- Approx. 3% higher performance of schoolwork
 - Approx. 1.5% lower absence rates



RENEW SCHOOL


Danish examples of schools



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RENEW SCHOOL

Starshaped with central 'heart' room



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- Division of school into smaller units
- Access to daylight (skylights)
- Efficient nighttime ventilation by opening of windows
- Decentral ventilation units in each classroom

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 **Small classrooms with plenty of satellite workspaces** 
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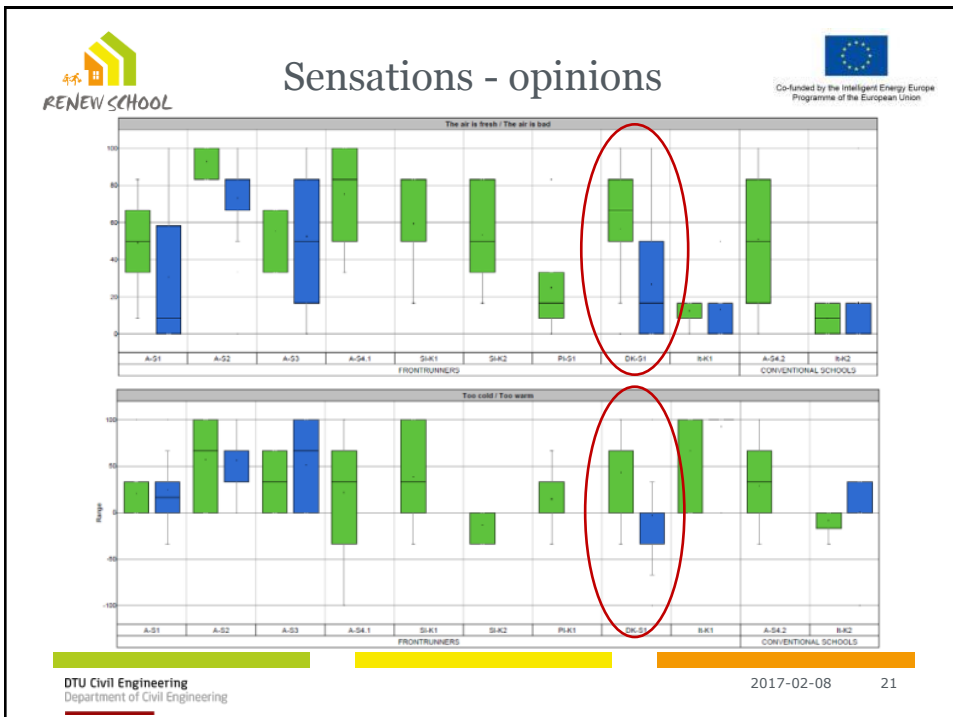
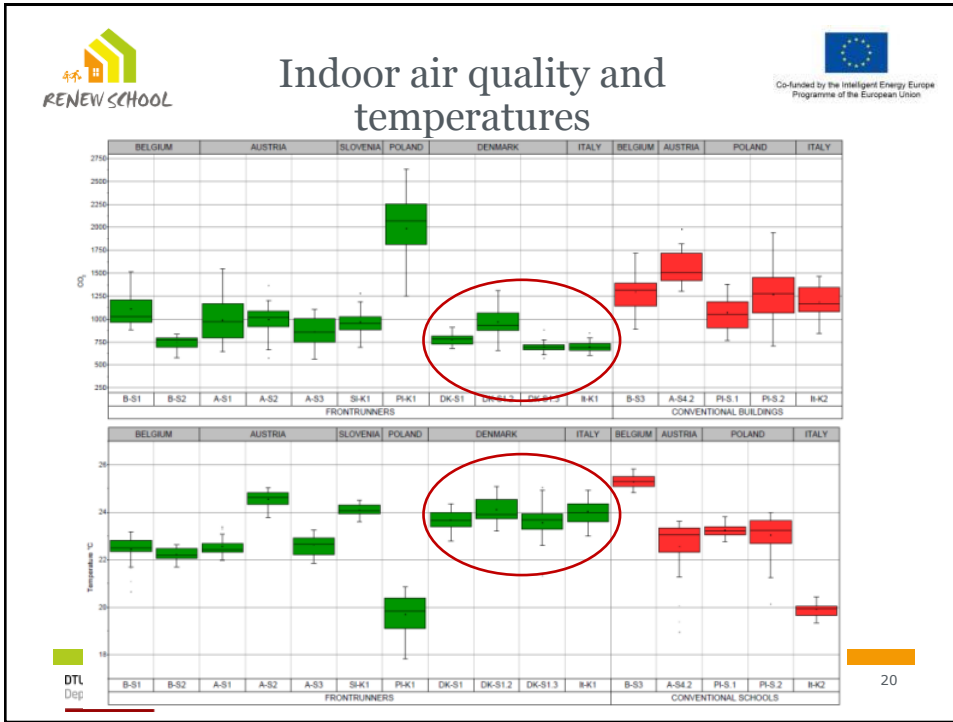
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 **Breaking down long hallways into smaller spaces** 
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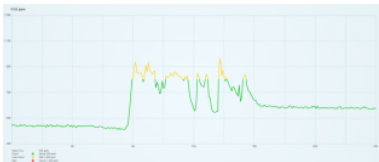





 **Decentral ventilation units** 
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 **Renovated and non-renovated classrooms** 
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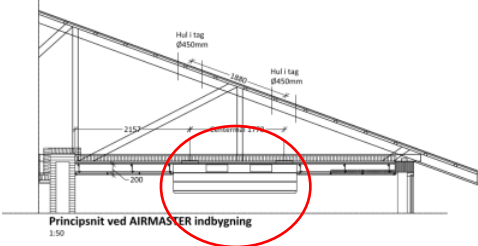


Decentral ventilation with improved acoustics and no draught risk

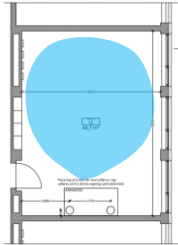


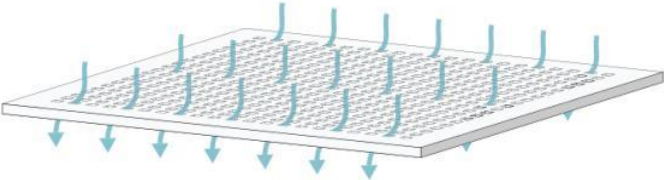
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Principsnit ved AIRMASTER indbygning
1:50







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Low-noise decentral ventilation

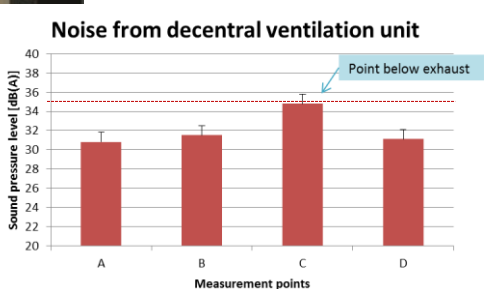


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Airsupply: 950 m³/h
CO₂-level: 1000 ppm

Noise from decentral ventilation unit



Measurement point	Sound pressure level [dB(A)]
A	~31
B	~32
C	~35
D	~31

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Thank you for your attention!
Questions?