

## Ventilation in Denmark – Status and Future Trends

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## Standards & Regulations

- New Building regulations in 2008 (replaces 1995 regulations)
- New Code of Practice for Mechanical Ventilations Systems in 2005, DS447 (replaced previous from 1981)
- Only minor changes regarding minimum air flow rates and criteria for IAQ
- The main changes with regard to ventilation are consequences of new demands for energy use
- Different indoor environmental quality levels are introduced

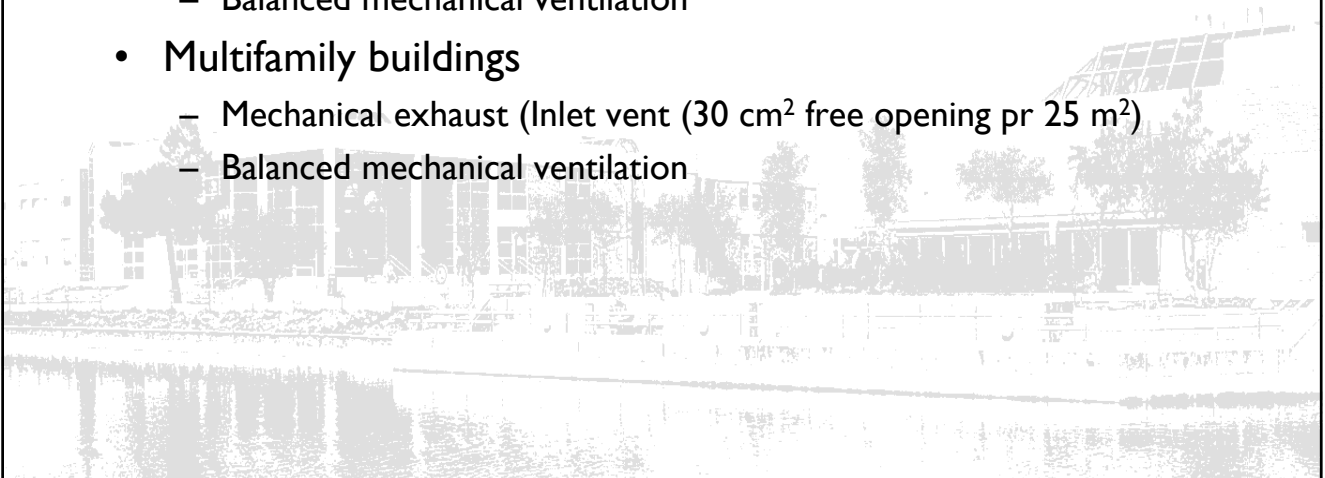
## Residences

### Minimum Air Flow Rates

- In every room as well as for the whole residence the supply of outdoor air shall be minimum  $0,35 \text{ l/s m}^2 \sim (0,5 \text{ h}^{-1}$  at normal room height)
- The air flow shall be provided on a 24 hours basis (demand control not allowed)
- Air shall be supplied either through vents, controlled windows or mechanical supply
- Air shall be exhausted from kitchen (20l/s), bathroom (15 l/s), toilet (15 l/s) and similar rooms
- All residences shall have a cooker hood in the kitchen with mechanical exhaust

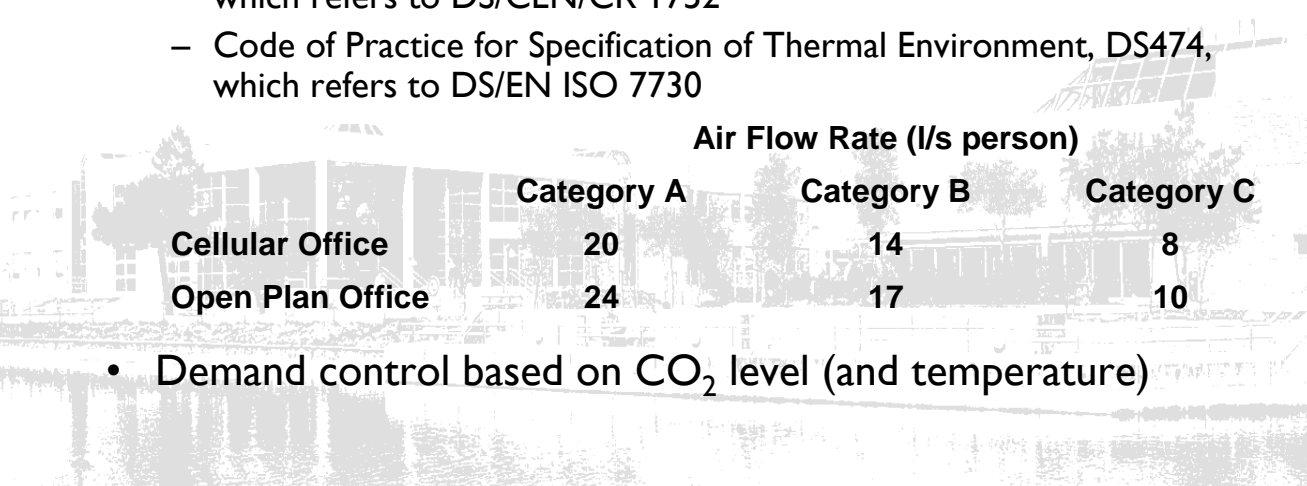
## Residences Technical Solutions

- Single family buildings, rowhouses, etc.
  - Natural ventilation (Inlet vent (60 cm<sup>2</sup> free opening pr 25 m<sup>2</sup>) and an openable window, Exhaust (200 cm<sup>2</sup> free opening))
  - Mechanical exhaust (Inlet vent (30 cm<sup>2</sup> free opening pr 25 m<sup>2</sup>)
  - Balanced mechanical ventilation
- Multifamily buildings
  - Mechanical exhaust (Inlet vent (30 cm<sup>2</sup> free opening pr 25 m<sup>2</sup>)
  - Balanced mechanical ventilation



## Office Buildings Minimum Air Flow Rates and Technical Solutions

- Can be provided by natural ventilation, hybrid ventilation and/or balanced mechanical ventilation
- Based on
  - Code of Practice for Mechanical Ventilations Systems, DS447, which refers to DS/CEN/CR 1752
  - Code of Practice for Specification of Thermal Environment, DS474, which refers to DS/EN ISO 7730



	Air Flow Rate (l/s person)		
	Category A	Category B	Category C
Cellular Office	20	14	8
Open Plan Office	24	17	10

- Demand control based on CO<sub>2</sub> level (and temperature)

## Other Buildings

### Minimum Air Flow Rates and Technical Solutions

- Kindergartens
  - Livingrooms (3 l/s child, 5 l/s adult and 0,4 l/s pr m<sup>2</sup> floor area)
  - Ventilation shall be provided by balanced mechanical ventilation
  - Demand control possible (CO<sub>2</sub>-level)
- Schools, etc
  - Auditorium and other teaching rooms (5 l/s person and 0,4 l/s pr m<sup>2</sup> floor area)
  - Ventilation shall be provided by balanced mechanical ventilation
  - Demand control possible (presence detection or CO<sub>2</sub>-level)

## Criteria for Energy Use for Ventilation

- Minimum heat recovery 65 %
- Specific Fan Power (SFP)
  - Constant air volume (CAV) 2.1 kW/(m<sup>3</sup>/s)
  - Variabel air volume (VAV) 2.5 kW/(m<sup>3</sup>/s)
  - Mechanical exhaust 1,0 kW/(m<sup>3</sup>/s)
  - Residences (CAV) 1,2 kW/(m<sup>3</sup>/s)
- Humidification can only be used if aspects related to production, security, conservation or health demand it

## Building Airtightness

- Building airtightness should be less than 1,5 l/s m<sup>2</sup> floor area at 50 Pa
- Documentation can be required in the building permit (minimum 5% of the cases)

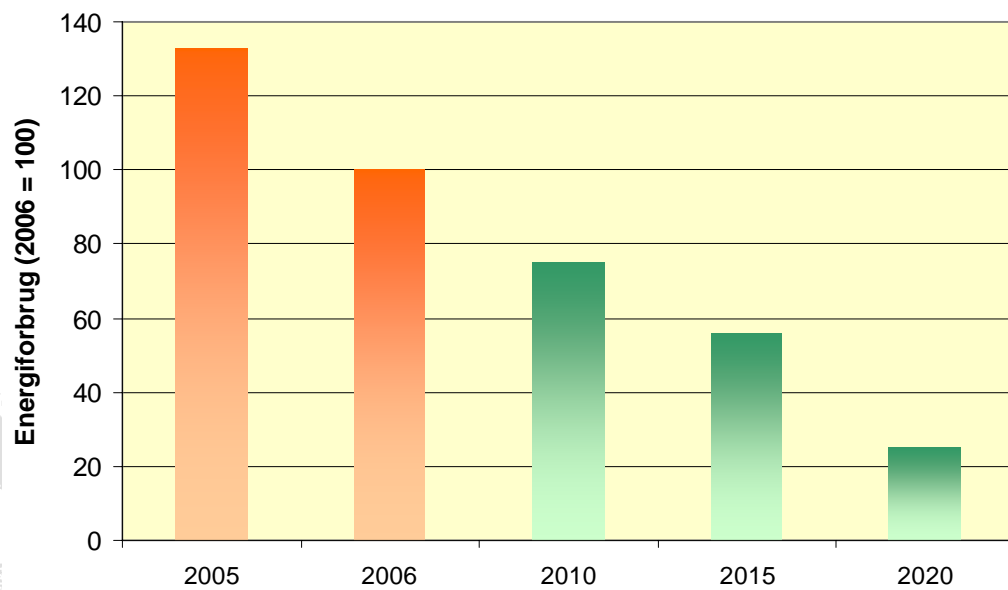


## Political Agreement of February 21, 2008

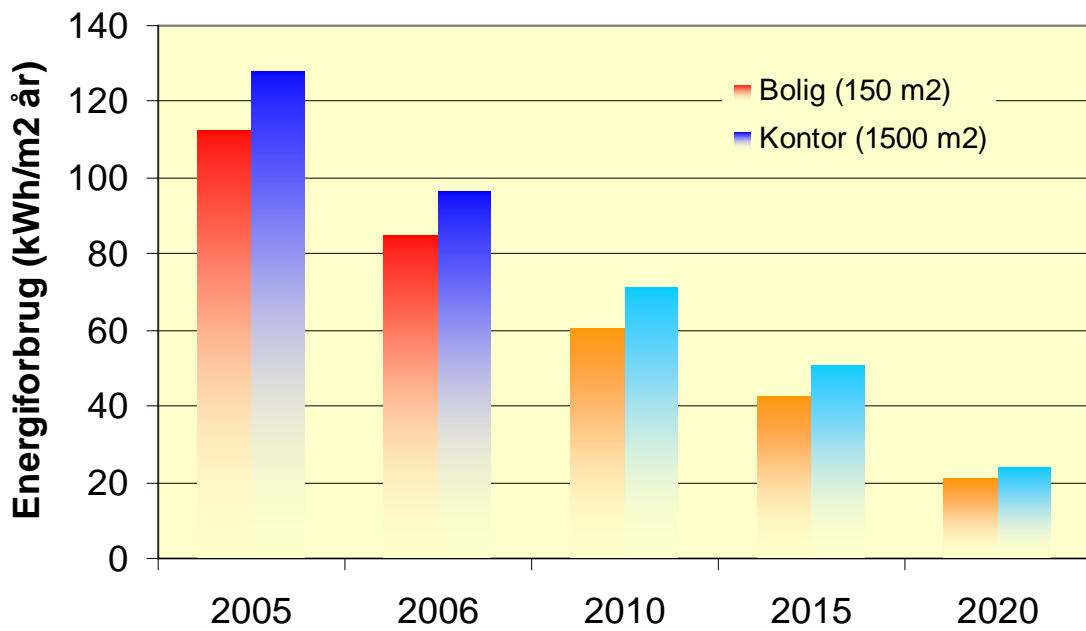


- 20% renewable energy in 2011 (minimum 30% in 2020)
- Energisavings on average 1,5% i 2010-2020 (total about 16%)
- Demands for energy use in new buildings are reduced by at least 25% in 2010, 2015 and 2020 to a maximum of 25% of todays demand in 2020.

## Development in Maximum Energy Use in New Buildings



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## Future Trends Ventilation in Residences

- Energy requirements drive a change towards balanced mechanical ventilation with heat recovery
- Heat recovery efficiency will have to increase from 65% to minimum 75%-80% in 2015 (keeping SFP at the same level or lower)
- Increased need for cooling in low energy residences – natural ventilation and night cooling needed
- Demand control in residences might be possible in the future, but this requires suitable criteria for health and comfort

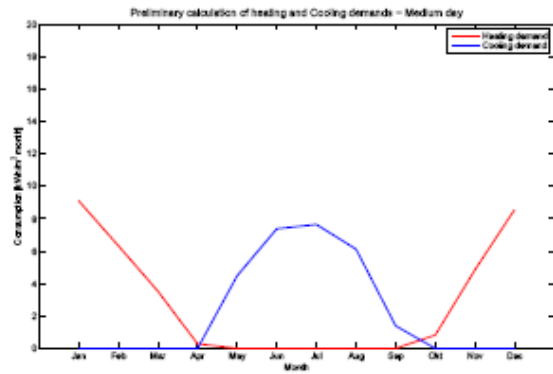
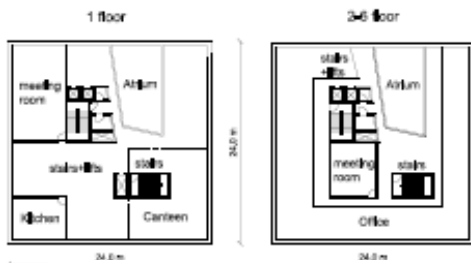
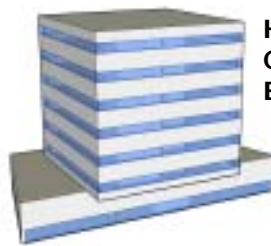
## Future Trends Ventilation in Offices

- The energy requirements drive a change towards balanced mechanical ventilation with heat recovery for IAQ in heating season. Even if a cooling need is always present during occupied hours
- Increased need for cooling in summer period – natural ventilation (window airing) and night cooling needed in all office buildings
- Discussions about impact on productivity. This might be an important factor in the future – lead to new developments to increase ventilation effectiveness (local and personalized ventilation)

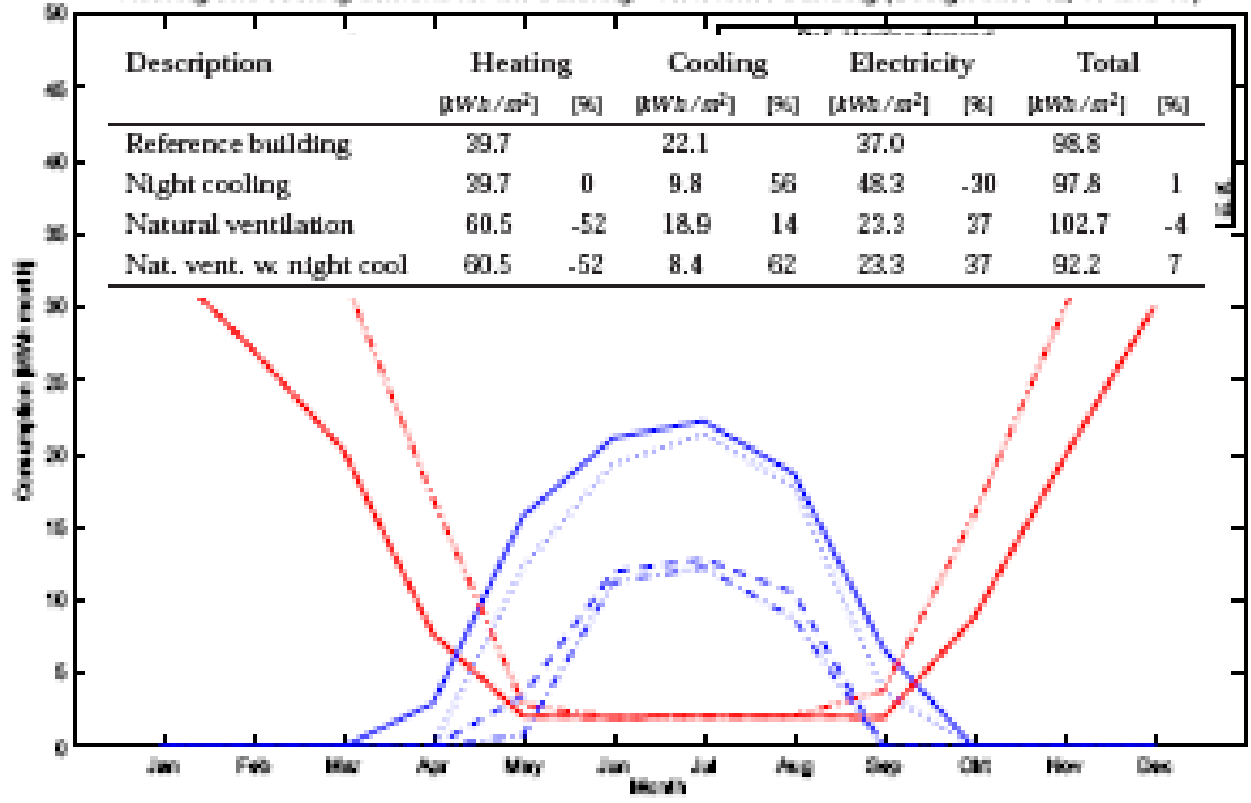
# Example: Office Building

Energy use 98,8 kWh/m<sup>2</sup> y

Heating 39,7 kWh/m<sup>2</sup> y  
 Cooling 22,1 kWh/m<sup>2</sup> y  
 Electricity 37 kWh/m<sup>2</sup> y

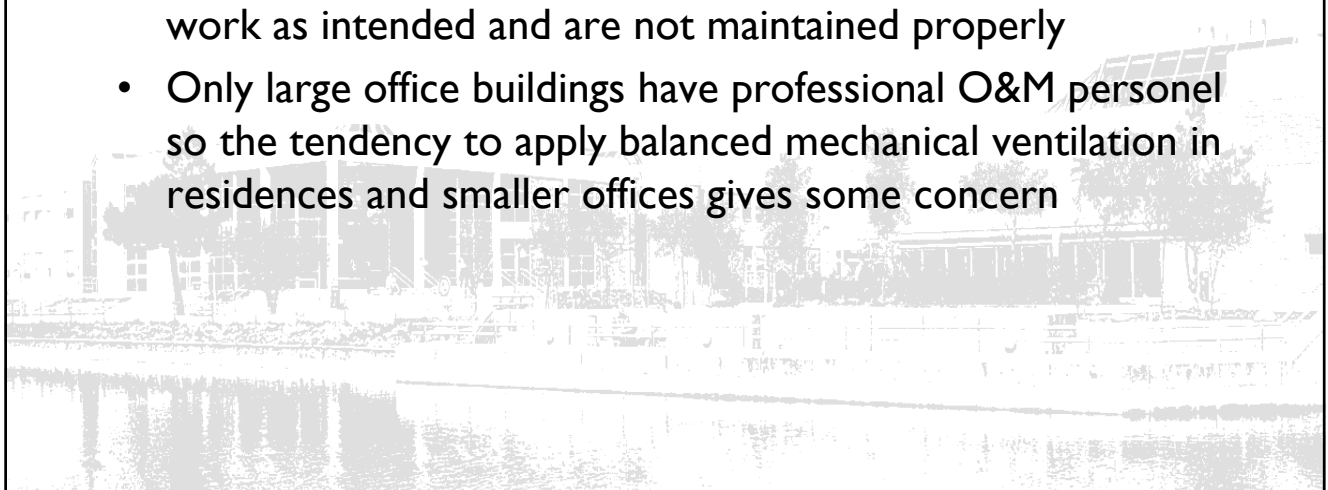


Heating and cooling demand for the building - Reference building (Design case 12, 15 and 16)



## Other issues

- A voluntary system for inspection and maintenance of ventilation systems exist, but is not very successful (participation)
- Experience shows that many ventilation systems do not work as intended and are not maintained properly
- Only large office buildings have professional O&M personel so the tendency to apply balanced mechanical ventilation in residences and smaller offices gives some concern



## Energy Performance Regulations

- No framework exist for the assessment of performance of innovative ventilation systems (or other innovative systems)
- The method to assess energy performance is gradually improved through implementation of new technologies (industry driven)

