Necessary Air Change Rate in a Danish Passive House

Rasmus L. Jensen and Camilla Brunsgaard

Aalborg University, Department of Civil Engineering

Introduction

- *The purpose*: Determine the necessary Air Change Rate in a Danish Passive House
- *Background*: Danish building regulations demands an air change rate of 0.5 h^{-1}

Why 0.5 h^{-1}

- Originates from the 70'
- Where introduced to reduce the growing number of buildings with moisture related problems
- Lacks to some extend scientific justification
- Main reasons to avoid high levels of RH in dwellings:
  - Avoid growth of mould fungus (RH < 70%)
  - Minimize the number of house dust mite (RH < 45% for minimum one or two month per year)

Building tradition

Danish buildings

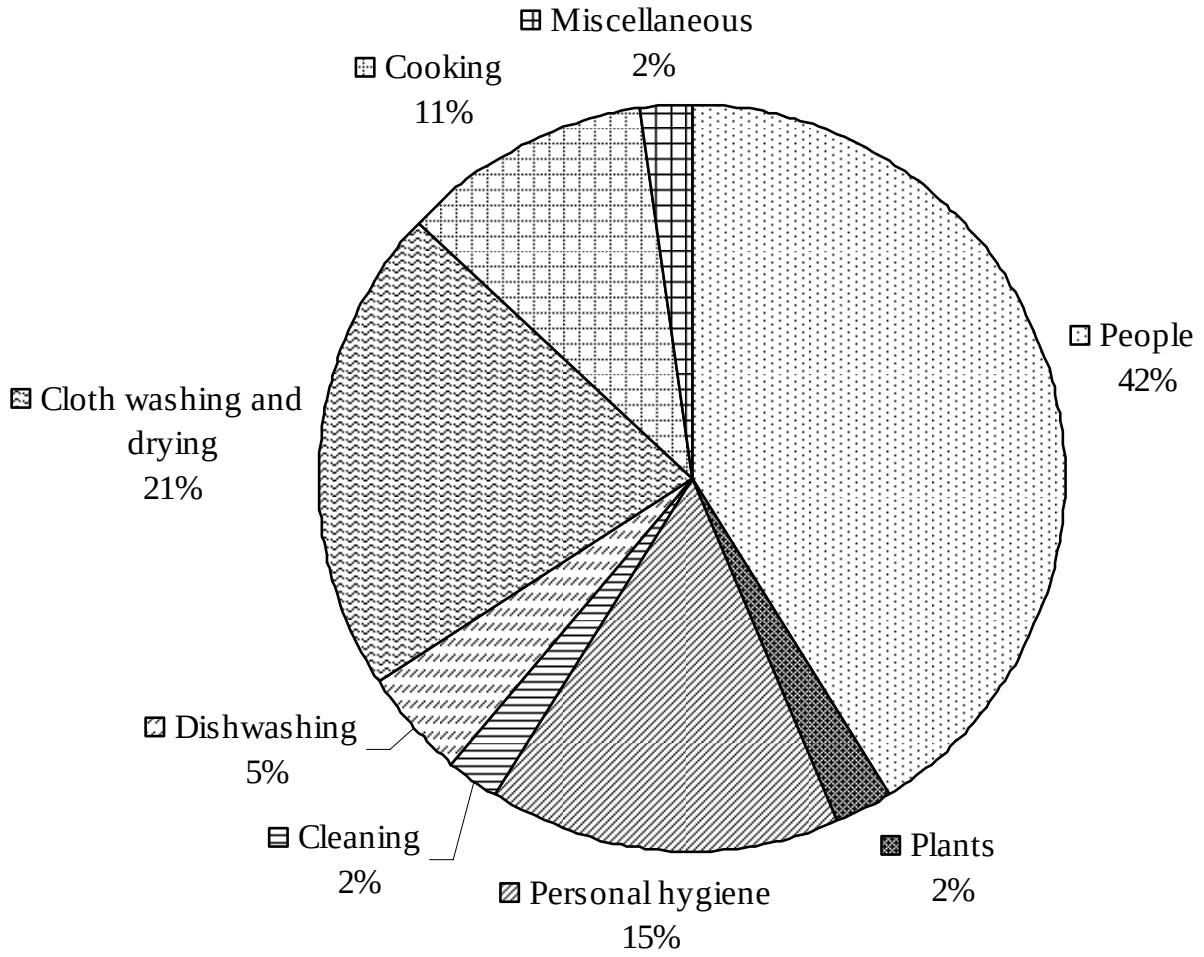
- Air change rate 0.5
- Recirculation of the air from the exhaust hoot not possible
- Drying cloth indoor possible

Passive house

- Air change rate from 0.3
- Recirculation of the air from the exhaust hoot is possible
- Drying cloth indoor possible

Moisture production

- Main contributions from
  - People
  - Cloth washing
  - Cooking



Moisture production

- The moisture production was determined based on literature studies and experiments as described by Koch et al. 1987

Moisture produced/number of people	1	2	3	4	5	6
People	0.88	1.75	2.63	3.50	4.38	5.25
Plants	0.20	0.20	0.20	0.20	0.20	0.20
Personal hygiene	0.33	0.65	0.98	1.30	1.63	1.95
Cleaning	0.20	0.20	0.20	0.20	0.20	0.20
Dishwashing	0.40	0.40	0.40	0.40	0.40	0.40
Cloth washing and drying	0.40	0.90	1.30	1.80	2.10	2.60
Cooking	0.90	0.90	0.90	0.90	0.90	0.90
Miscellaneous	0.00	0.10	0.20	0.20	0.40	0.50

- Resulting in a total moisture production with out people of 5,83 kg/day

Moisture production - people

- Distribution and number of people based on two large Danish studies:
  - Average time spend at home per weekday: 16.3 h
  - Average time where the home was empty: 5.4 h

Hour	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1	5	5	5	5	5	5	5
2	5	5	5	5	5	5	5
3	5	5	5	5	5	5	5
4	5	5	5	5	5	5	5
5	5	5	5	5	5	5	5
6	5	5	5	5	5	5	5
7	5	5	5	5	5	5	5
8	5	5	5	5	5	5	5
9						5	5
10						5	5
11						5	5
12						3	3
13						3	3
14						3	3
15					3	3	3
16					3	3	3
17	3	3	3	3	3	3	3
18	3	3	3	3	3	3	3
19	3	3	3	3	3	3	3
20	3	3	3	3	3	3	3
21	5	5	5	5	5	5	5
22	5	5	5	5	5	5	5
23	5	5	5	5	5	5	5
24	5	5	5	5	5	5	5

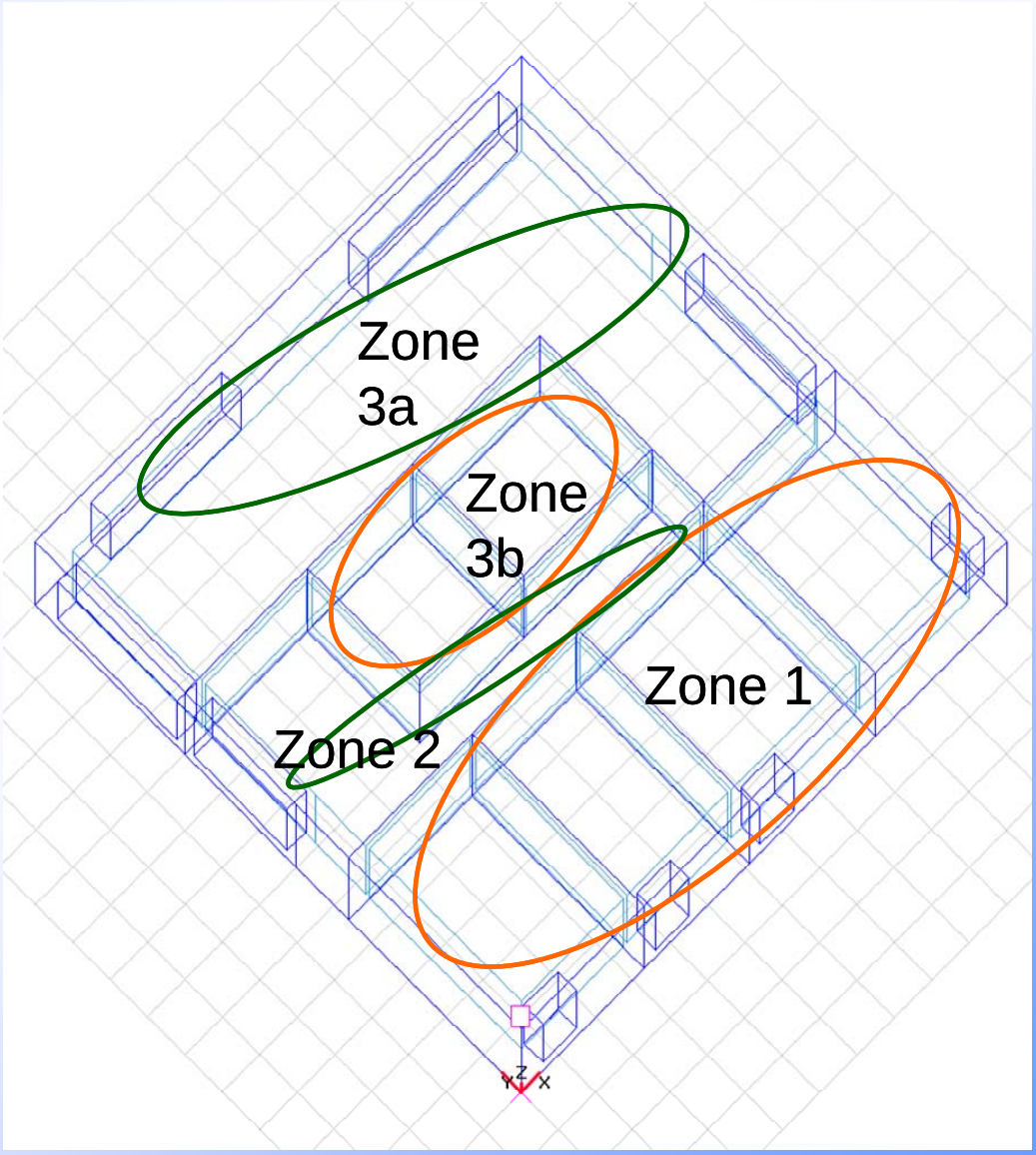
The house

- 169 m^2 (gross area)
- Inhabited by a family of 5 (33,8 m^2 per person)

The floor plan

Zoning the building

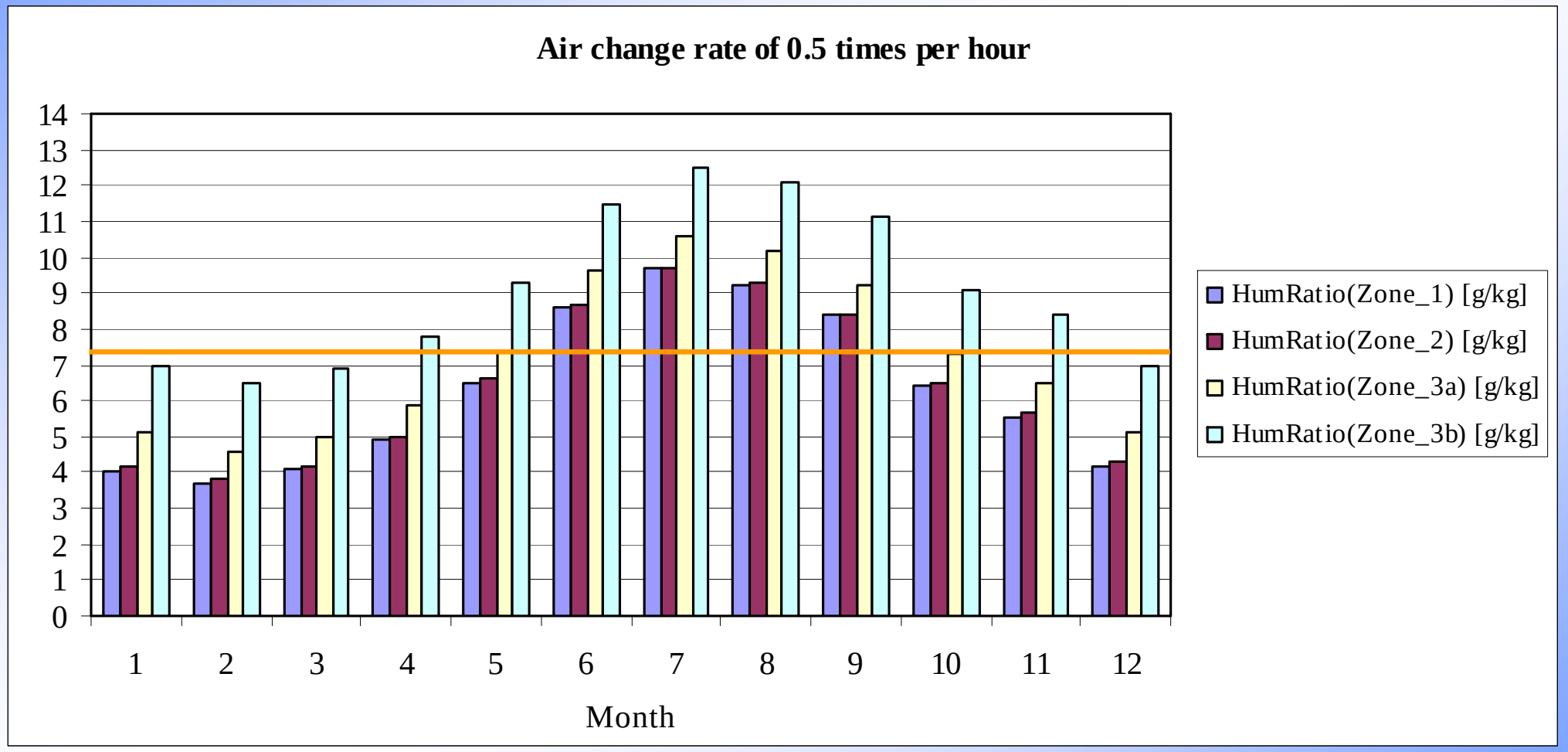
- Ventilation:
  - In: Zone 1
  - Through: Zone 2
  - Out: Zone 3
- Moisture:
  - Plants, Cleaning and Misc.: Evenly distributed
  - Personal hygiene, washing and drying cloth: Zone 3b
  - Dishwashing and cooking: Zone 3a
- People:
  - Night time (23 - 7): Zone 1
  - Daytime (7 – 23): Zone 3a



Air change rates

- Four different air change rates where examined:
  - 0.5 (Danish building regulations)
  - 0.4 (Reduced)
  - 0.36 (Based on number of people and building type)
  - 0.3 (lower limit)

Results



- RH of 45 % at 22°C ~ 7,4 g/kg

Results

Air change rate	0.5		0.4		0.36		0.3	
Time of the year	Winter	Heating season	Winter	Heating season	Winter	Heating season	Winter	Heating season
HumRatio(Zone_1) [g/kg]	4,0	4,7	4,1	4,8	4,3	4,9	4,4	5,0
HumRatio(Zone_2) [g/kg]	4,1	4,8	4,3	5,0	4,5	5,2	4,7	5,3
HumRatio(Zone_3a) [g/kg]	4,9	5,6	5,4	6,1	5,7	6,3	6,1	6,7
HumRatio(Zone_3b) [g/kg]	6,8	7,5	7,0	7,7	7,7	8,3	8,2	8,8

RH at 22°C	20	30	40	45	50	60	70	80
Humidity ratio g/kg	3,2	4,8	6,6	7,4	8,3	9,9	11,6	13,2

Conclusion

- It seems that an air change of 0.5 h^{-1} is not needed to avoid moisture related problems
- Air change as low as 0.36 or even 0.3 can remove the moisture produced in the building sufficiently
- The needed air change depends heavily on the use of the building therefore demand controlled ventilation could prove to be an optimal solution