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Experience with measurements, ventilation and infiltration in the active house concept
Quality issues and implications for compliance

AIVC QMM Workshop 2014

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Active House Alliance

- members and target groups

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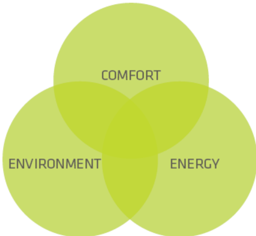
Active House Vision

- buildings that gives more than they take

Active House is a vision of buildings that create healthier and more comfortable lives for their occupants without impacting negatively on the climate



Comfort
– *creates a healthier and more comfortable life*
An Active House creates healthier and more comfortable indoor conditions for the occupants, ensuring a generous supply of daylight and fresh air. Materials used have a neutral impact on comfort and indoor climate.

Energy
– *contributes positively to the energy balance of the building*
An Active House is energy efficient. All energy needed is supplied by renewable energy sources integrated in the building or from the nearby collective energy system and electricity grid.

Environment
– *has a positive impact on the environment*
An Active House interacts positively with the environment through an optimised relationship with the local context, focused use of resources, and its overall environmental impact throughout its life cycle.

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Active House Specification

- buildings that gives more than they take

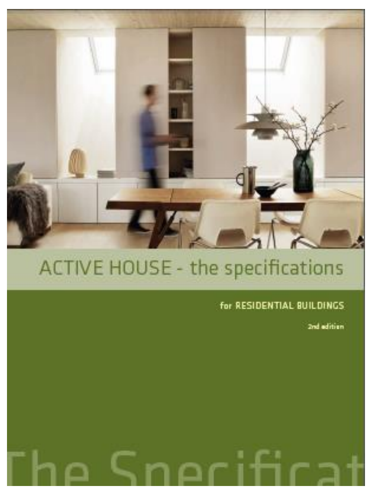
Quantitative Criteria
Ratings: 1 (best) – 4 (acceptable)

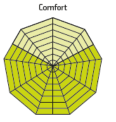
Comfort
- Daylight
- Thermal environment
- Indoor air quality

Energy
- Energy demand
- Energy supply
- Energy performance

Environment
- Environmental loads
- Freshwater consumption
- Sustainable construction

Qualitative Criteria; checklist



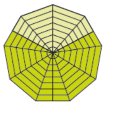


Indoor Air Quality

PARAMETER	VALUE	CRITERIA	SCORE
1.3.1 Standard fresh air supply		The fresh air supply shall be established according to the below limit values for indoor CO_2 concentration in living rooms, bedrooms, study rooms and other rooms with people as the dominant source and that are occupied for prolonged periods: 1. 500 ppm above outdoor CO_2 concentration 2. 750 ppm above outdoor CO_2 concentration 3. 1000 ppm above outdoor CO_2 concentration 4. 1200 ppm above outdoor CO_2 concentration	

Methodology
Based on EN 15251

- Air change rate must be individually adjustable in each room
- Any type of ventilation system can be used
- No specific requirements for airtightness, but *energy* requirements must be met (indirect requirement for airtightness)



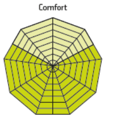
Thermal Comfort

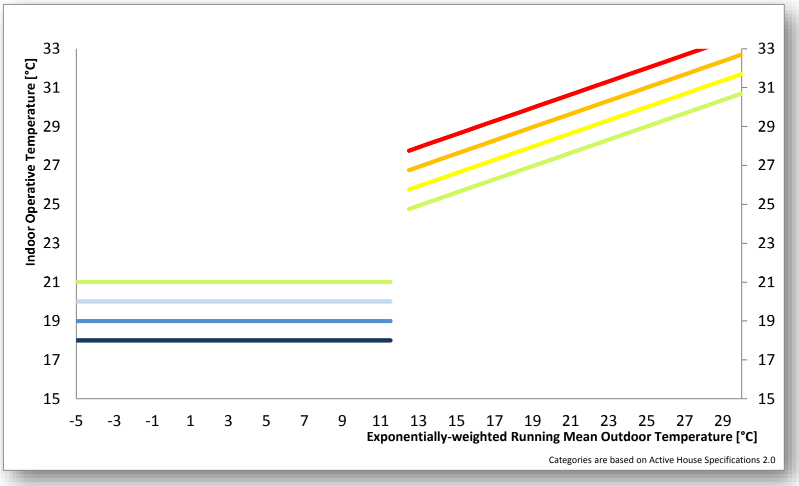
PARAMETER	VALUE	CRITERIA	SCORE
1.2.1 Maximum operative temperature		The maximum indoor temperature limits apply in periods with an outside T_{rm} of 12°C or more. For living rooms, kitchens, study rooms, bedrooms etc. in dwellings without mechanical air conditioning and with adequate opportunities for natural (cross or stack) ventilation, the maximum indoor operative temperatures are: 1. $T_{i,o} < 0.33 \times T_{rm} + 20.8°C$ 2. $T_{i,o} < 0.33 \times T_{rm} + 21.8°C$ 3. $T_{i,o} < 0.33 \times T_{rm} + 22.8°C$ 4. $T_{i,o} < 0.33 \times T_{rm} + 23.8°C$ T_{rm} is the Running Mean outdoor temperature as defined in 'chapter 3.11 External temperature, running mean of EN 15251:2007'. For living rooms etc. in residential buildings with air conditioning, the maximum operative temperatures are: 1. $T_{i,o} < 25.5°C$ 2. $T_{i,o} < 26°C$ 3. $T_{i,o} < 27°C$ 4. $T_{i,o} < 28°C$ For bedrooms (especially at night time), a 2°C lower value should preferably be used than indicated above as people are more sensitive to high temperatures when sleeping or trying to fall asleep.	

Methodology
Based on EN 15251
Adaptive comfort for naturally ventilated buildings

- Means to prevent overheating (solar shading, window openings, mechanical cooling) must be individually adjustable in each room
- Means to control heating system must also be adjustable at room level

Adaptive Thermal Comfort





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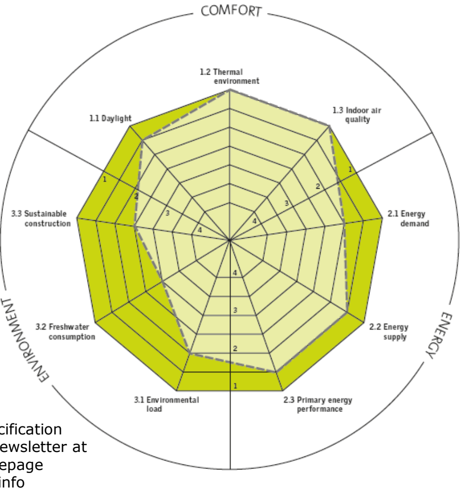
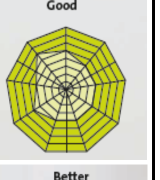
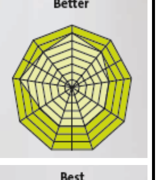
Active House Specification
- performance in the radar diagram







Download the Specification
and subscribe to newsletter at
Active House Homepage
www.activehouse.info

Experiences from completed Active Houses

Energy performance

- The four first projects have demonstrated that the energy targets of 2020 can be achieved with the knowledge, technology and building components that were available when the houses were planned in 2008–2010
- In some cases the energy performance has been communicated by the consultants based on national compliance tools − which can be misleading, as compliance tools are not necessarily made to predict the actual energy consumption of the completed buildings
- The actual occupants behavior, control system setup and quality of components and construction had a significant impact on the results
- Based on these experiences, it is evident that it would create more value for a customer if the calculated energy consumption is communicated as a range of values − because the actual performance depends on the actual use of the building

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Typical ventilation systems

- Hybrid ventilation based on mixed-mode strategy
  - Natural ventilation when outdoor temperature is "high" (e.g. above 12,5°C)
  - Mechanical ventilation with heat recovery when outdoor temperature is "low" (e.g. below 12,5°C)
- Demand-controlled ventilation with CO2-level as indicator (typically ~ 900 ppm set point)
- Window opening for summer thermal comfort (ventilative cooling): control based on indoor temperature (e.g. 24°C set point)

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Airtightness

	Home for Life DK, 2009	Sunlighthouse AT, 2010	Maison Air et Lumiére F, 2011	Carbonlight Home GB, 2011	LichtAktiv Haus D, 2010
n50 (h^{-1})	1,5	0,5	0,6	-	1,1
l/s/m² @ 50 Pa	-	-	-	1,3	-

Experience from completed Active Houses:

- The achieved airtightness is related to the competence level of the craftsmen building the house.
- The competence level has increased in the relatively short period from 2009 to 2011
- ..possibly due to increased awareness of the importance of airtightness for low energy buildings
- Satisfying airtightness can be achieved, and not a big challenge, compared to others

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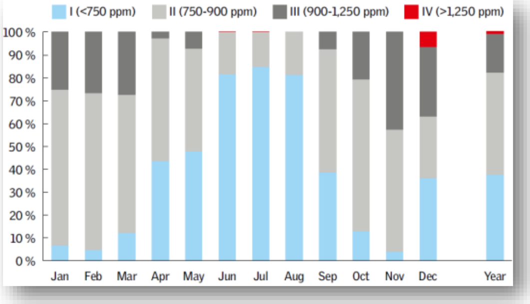
Measured IAQ



Kitchen-dining room LichtAktiv Haus in Germany (naturally ventilated) Absolute, measured values

Criteria according to EN 15251

- Best IAQ in summer; CO2 levels in category I or II almost all hours (side-effect of ventilative cooling)
- In winter, 20-30% of hours in category III – acceptable annual result
- Is it the right criteria? From EN 15251 "offices" – how to evaluate the IAQ in dwellings, especially bedrooms?
- General experience that both NV and MV delivers acceptable IAQ

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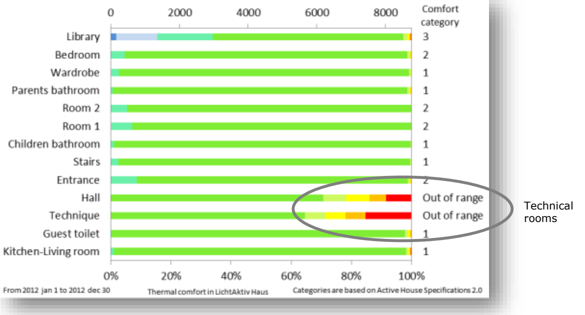
Measured thermal comfort



Kitchen-dining room LichtAktiv Haus in Germany (naturally ventilated)

Criteria according to Active House Specification (corresponds to EN 15251)

- The experience is that excellent daylight conditions can go hand-in-hand with good thermal comfort
- Overheating can be prevented with the right measures
- .. dynamic solar shading, overhangs, ventilative cooling

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Use of windows for ventilative cooling

Kitchen/dining room
LichtAktiv Haus

Cat 1 or 2, windows closed
Cat 1 or 2, windows open
Cat 3 or 4, windows closed
Cat 3 or 4, windows open

Category refers to Active House / EN 15251 category

"Open window" if one or more windows are open in the room

- Window openings are used during all hours of the day from May to September (incl. night cooling)
- Airings at 8:00 and 20:00 in transition periods
- Window openings (ventilative cooling) support good thermal comfort

ARMINES

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High air flows with ventilative cooling can be measured and calculated

		South bedroom temp	North bedroom temp	Bath room temp	Wind speed m/s	Tracer Gas ACH	Simulated CONTAM ACH
Morning	Closed door	23.7	21.3	22.5	3.6	13.4	13.9*
	Open door	23.7	21.3	22.5	2.8	22.5	20.6
Afternoon	Closed door	27.1	26.5	26.2	2.3	13.2	16.6*
	Open door	27.1	26.5	26.2	2.3	19.8	19.5
Morning	Closed door	24.2	22.5	23.3	3.6	13.4	14
	Open door	24.2	22.5	23.3	3.6	14.6	17.4
Afternoon	Closed door	26.5	25.2	25	2.9	10.6	13.2
	Open door	27	26.1	25.6	2.8	13.1	17

Good correspondence between measured and simulated air change rate – max 30% difference per case, 10% difference in average

Measurements performed in Maison air et Lumiere by Armines in France in cooperation with VELUX

But calculation standards underestimate **high** air flows

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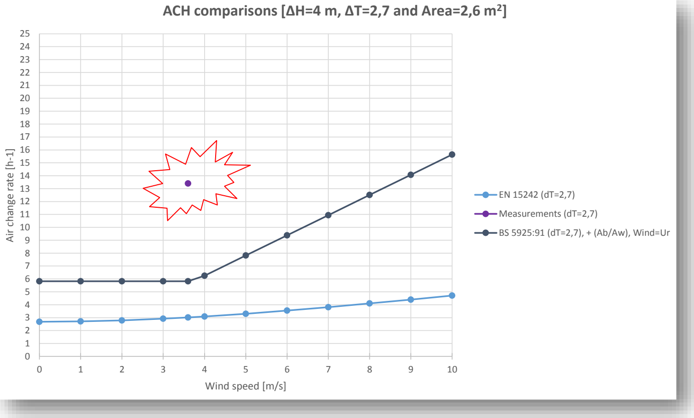

- True and fair calculation methods are important for practical application of ventilative cooling (EN 15242 under revision, new calculation method is being discussed)

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Ventilative cooling, theory and practice

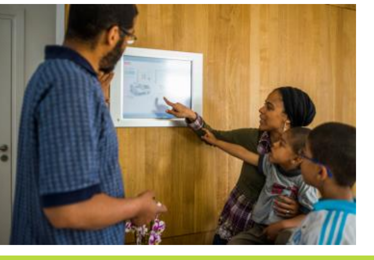
- Ventilative cooling performs well in practice
- Ventilative cooling performs well in theory
- Ventilative cooling is not sufficiently supported by standards
- Ventilative cooling is not sufficiently supported by many compliance tools
- Ventilative cooling is therefore difficult to apply in practice
- Venticool.eu and IEA Annex 62 have been initiated to facilitate the practical application of ventilative cooling

venticool
the international platform for ventilative cooling

IEA EBC
Annex 62
The IEA project
on ventilative cooling
EBC

Control systems are important

- The control of windows, solar shading, mechanical ventilation, etc. must be simple and intuitive
- The automatic control system must be intuitive and transparent for the users (more important than simple)
- Occupants must always be able to override the system and make manual activations
- The switch between mechanical and natural ventilation can be based on exterior temperature
- Lack of simple and affordable control systems for residential buildings currently on the market
- Occupants are interested in the performance of their house



Renovation projects increase in no.'s

- De Poorters van Montfoort in Netherlands:
  Ten row houses in social housing association renovated as Active House within public budget frame
  Hybrid ventilation (NV with MV extract)
- LichtAktiv Haus in Germany:
  Typical 1950's "settler house" renovated to CO_2 neutral level
  Natural ventilation all year
- From "energy renovation" to "climate renovation"

Summary

- Energy performance should be determined as a range, based on realistic estimations on user behavior and component performance
- The competence level on practical airtight construction is increasing and not a big challenge
- Good IAQ can be achieved with both mechanical and natural ventilation systems; hybrid ventilation has best energy performance
- Use of ventilative cooling improves summer IAQ as a side-effect of ventilative cooling
- Preventing overheating is a very important issue, and focus on this issue is needed
- Use of dynamic solar shading and natural ventilation (ventilative cooling) is able to eliminate overheating, also in buildings with high daylight levels
- Ventilative cooling needs better support in standards and compliance tools
- Transparent and intuitive control systems are important, and affordable systems for residential buildings are needed
- Shift in focus from new buildings to renovation of existing buildings (climate renovation)

Thanks for listening!

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