



Natural Ventilative Cooling

- Automated window ventilation

Heinz Hackl
VELUX Österreich GmbH

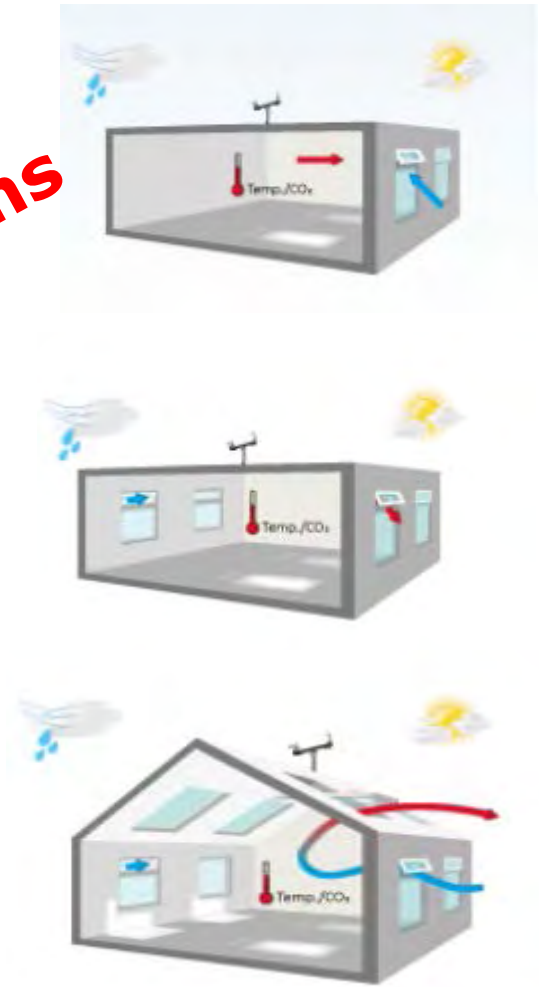
Agenda

- ▶ **Experience in practice: examples**
- ▶ **Control systems:
high tech – low tech – right tech?**
- ▶ **Components/Configuration of a NVC system**
- ▶ **Extension to need based window ventilation**
- ▶ **Maintenance**
- ▶ **Questions/discussion**

Principles of natural ventilation

- ▶ Single-sided ventilation
- ▶ Cross-ventilation
- ▶ Stack effect

**Passive cooling systems
without using energy
= "low-tech"**





Realised projects

VELUX ModelHome 2020 Home for Life, Dk



AART / architects

Residential Home; new built



2016

Mechanical Ventilation + NVC

VELUX ModelHome 2020

Home for Life, Dk

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AART / archi
tects



2016

VELUX ModelHome 2020 Green Lighthouse, Dk

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Christensen & Co

Office Building; new built



Mechanical Ventilation + NVC

VELUX ModelHome 2020 LichtAktivhaus, D

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Katharina Fey, TU Darmstadt
Ostermann Architekten

Residential Home; renovation



2016

Need based window ventilation + NVC

VELUX ModelHome 2020

LichtAktivhaus, D



Katharina Fey, TU Darmstadt
Ostermann Architekten



VELUX ModelHome 2020 Carbon Light Home, GB

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hta

Residential Home; new built



Mechanical Ventilation + NVC

Active House in Russia

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Residential Home; new built



Mechanical Ventilation + NVC

2016

Active House in Russia



VELUX ModelHome 2020 Sunlighthouse



juri troy architects



Automatically controlled windows:
Positive experience
High sophisticated control system

➔ Simplification possible?

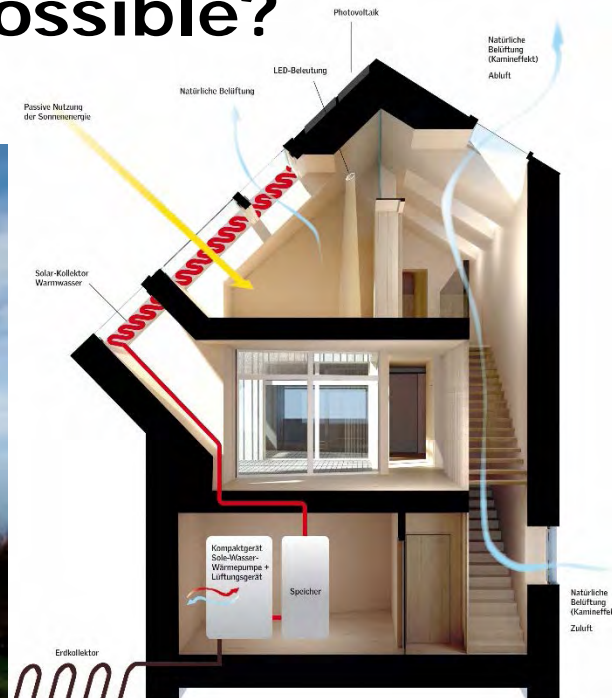


Foto: Adam Mørk

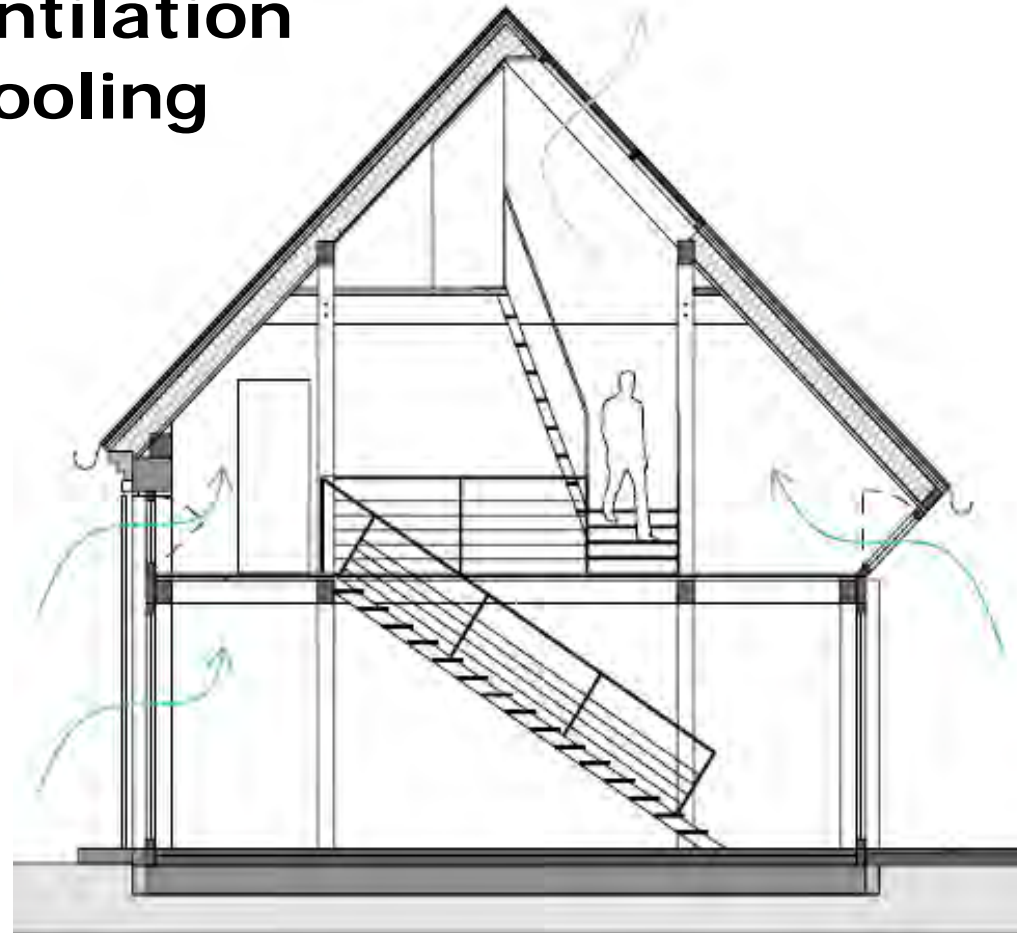
Foto: Adam Mørk

Project: Zu-Haus, Auersthal, Lower Austria



Need based window ventilation + Natural Ventilative Cooling

martin ruehrnschopf **architecture**



© martin ruehrnschopf architecture

Ventilation concept

2016

Project: Zu-Haus, Auersthal, Lower Austria

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2016

Project: Zu-Haus, Auersthal, Lower Austria

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2016

Project: Zu-Haus, Auersthal, Lower Austria

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picture: Jörg Seiler

martin ruehrschopf **architecture**

2016

Project: Zu-Haus, Auersthal, Lower Austria



Inlet air

Project: Zu-Haus, Auersthal, Lower Austria



Project: Zu-Haus, Auersthal, Lower Austria

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2016



Effect of Natural Ventilative Cooling - Monitoring results

VELUX ModelHome 2020

Maison Air et Lumiere

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NOMADE
ARCHITECTES



picture: Adam Mørk



picture: Adam Mørk

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2016

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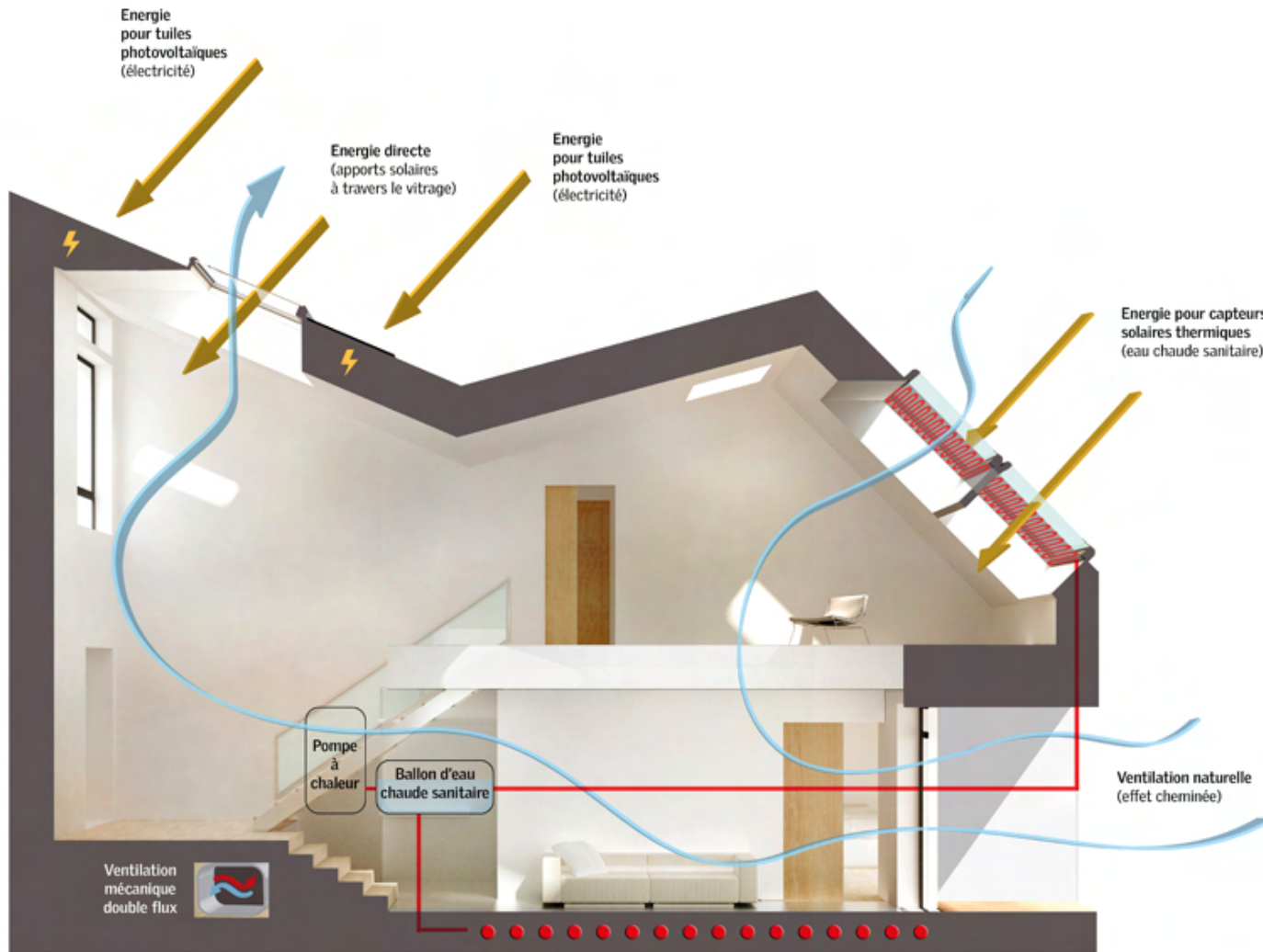
NOMADE
ARCHITECTES



2016

VELUX ModelHome 2020

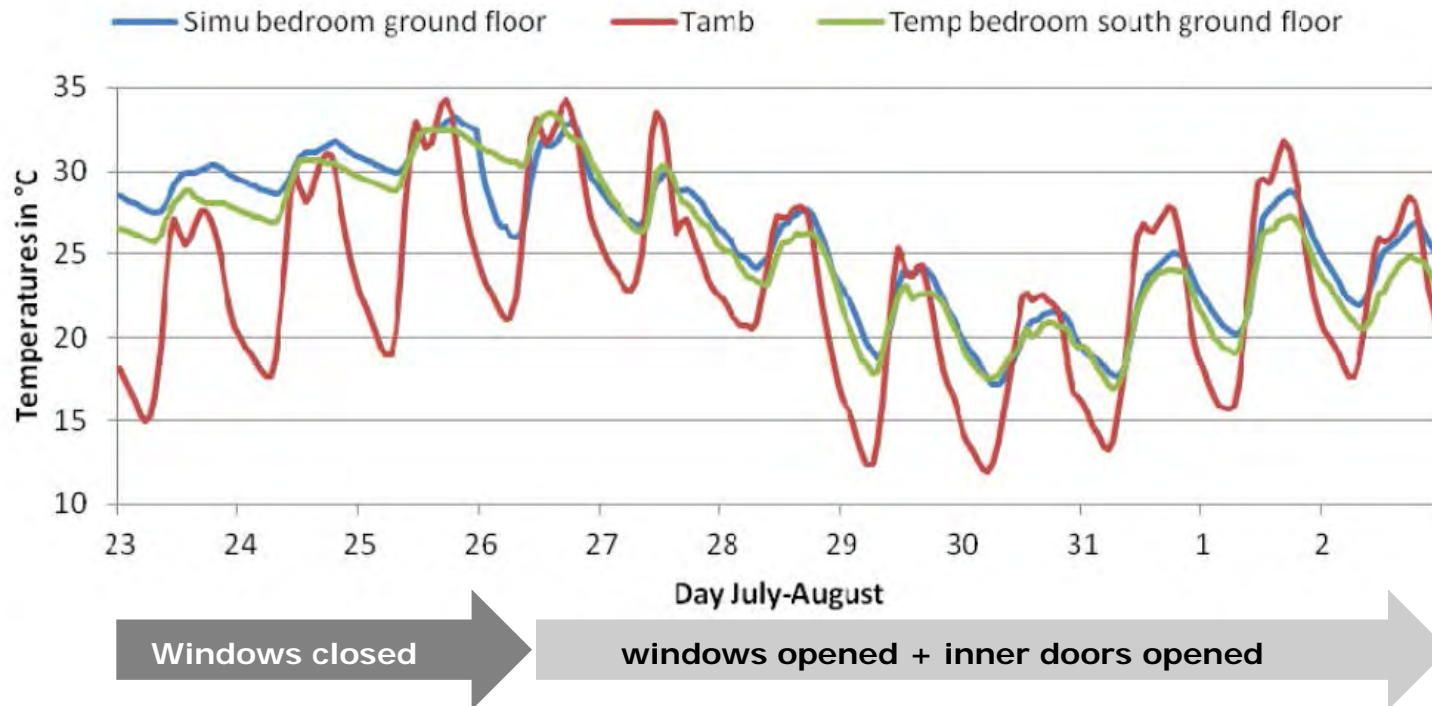
Maison Air et Lumière



VELUX ModelHome 2020 Maison Air et Lumiere



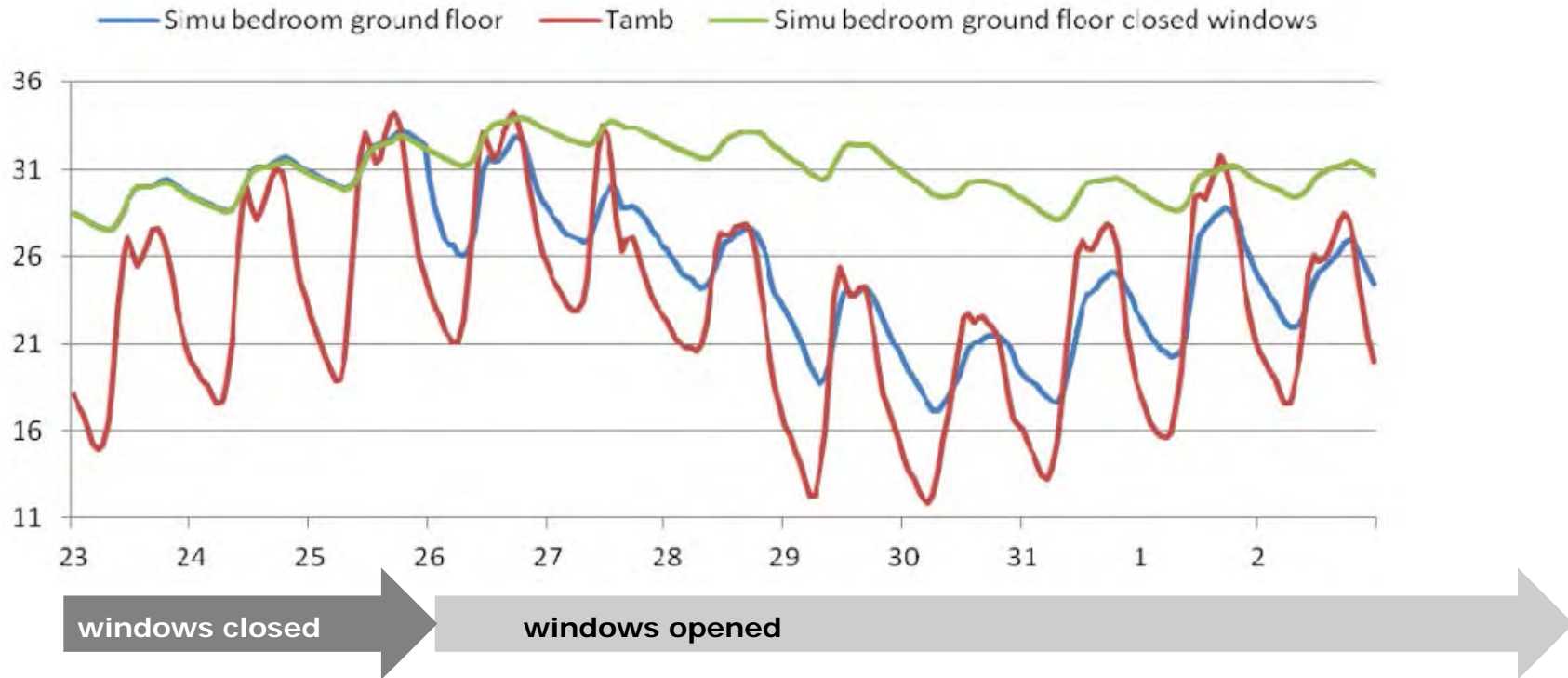
Evaluation of NVC



VELUX ModelHome 2020

Maison Air et Lumiere

Evaluation of NVC



Cooling effect of ~ 5 K during one night
= 5 x as efficient as french norm for calculation

VELUX ModelHome 2020

Maison Air et Lumiere



Simulated and measured air exchange rate (per hour!) of NVC

		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

Project: Zu-Haus, Auersthal

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Monitoring: 1 year + 1 summer

Quantitative monitoring:

- ▶ CO₂-concentration
- ▶ humidity
- ▶ room temperature

Qualitative monitoring:

- ▶ user satisfaction (daily)
- ▶ intervention by remote control?
 - If yes: why?.....and when?
- ▶ possible effects on health and wellbeing



IBO

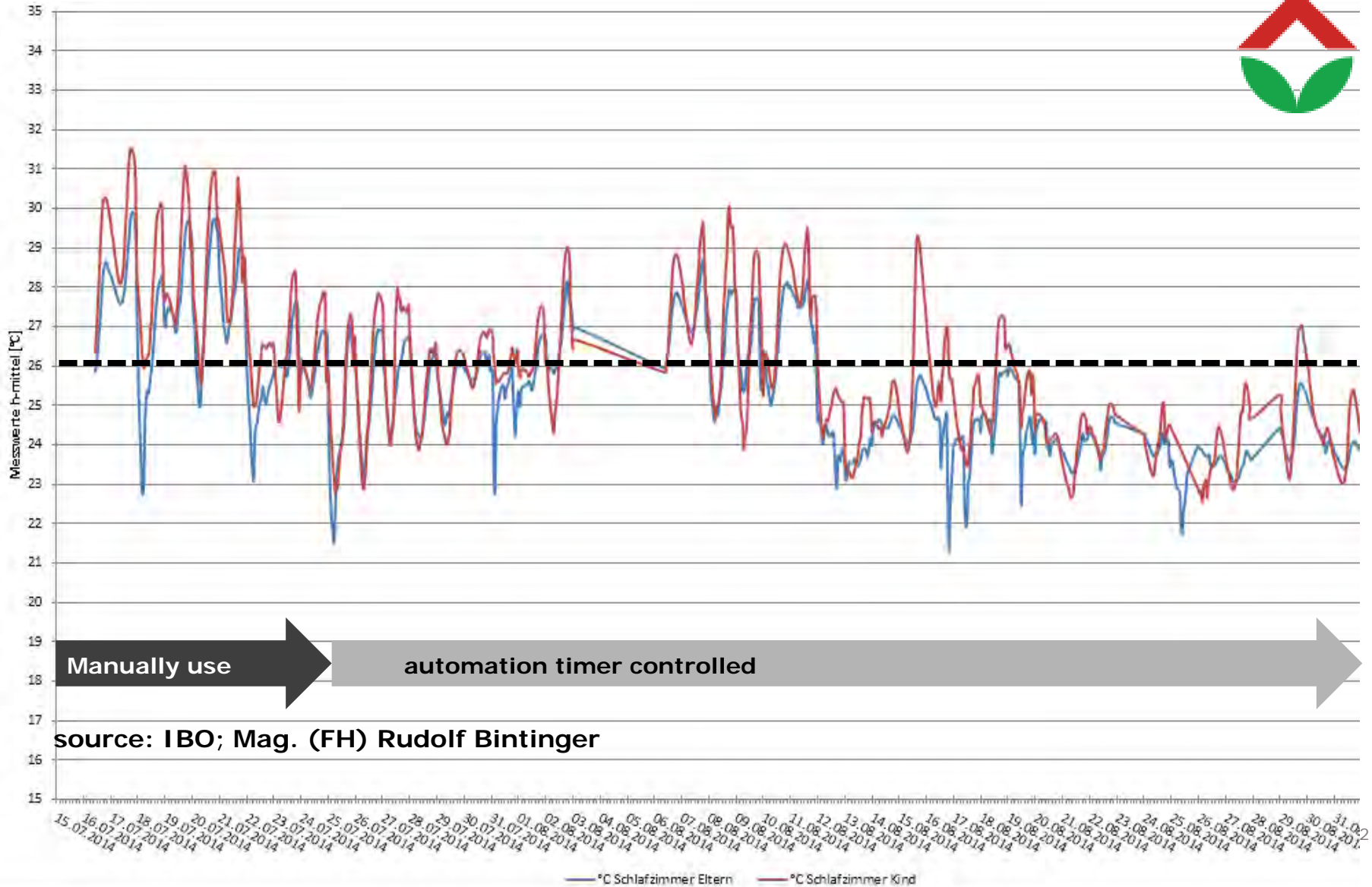
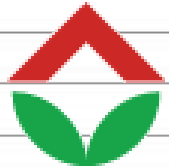
IBO Innenraumanalytik OG



Projekt: Zu-Haus, Auersthal



Quantitative monitoring summer 2014



source: IBO; Mag. (FH) Rudolf Binting




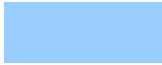

Project: Zu-Haus, Auersthal

Qualitative monitoring summer 2014



picture: Bettina Dürrheim

Döllinger family:

	hot	0 days	-
	warm	2 days	Therefrom 1 day cool in the evening
	Neutral/convenient	4 days	-
	chilly	7 days	Therefrom 6 days system „off“
	cold	4 days	Therefrom 3 days system „off“

Questionnaire july 29th – august 31st

9 Tage system switched off because too cool

Other days: family not at home

Projekt: Zu-Haus, Auersthal

Qualitative monitoring 2014



Hans Döllinger:

“.....if you come home after longer absence you quickly achieve good indoor air quality”

“.....rooms cool down quickly though the nights had been relatively hot.”

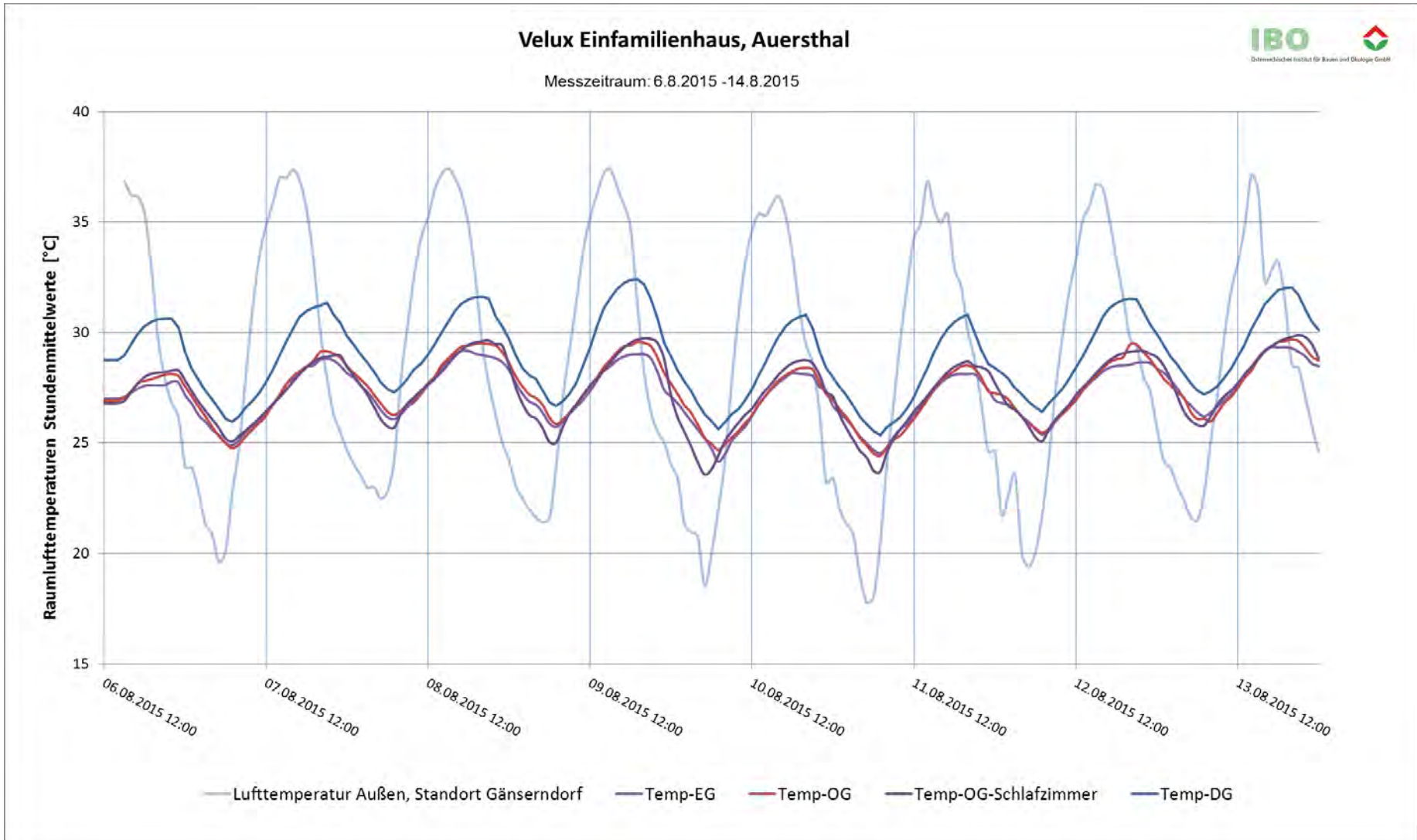
“We always had a good night`s sleep.”

“ Especially our daughter found temperatures during the night even too chilly”

“....we never kept the windows open for the whole night but always closed via remote control”

Projekt: Zu-Haus, Auersthal

Quantitatives Monitoring Sommer 2015



Projekt: Zu-Haus, Auersthal

Quantitative monitoring summer 2015



Monitoring: summary of IBO

- ▶ Very hot week; max. outdoor temperatures 36° C – 37° C
- ▶ Decrease of temperature during the night 18° - 23°C
(reference weather station Gänserndorf)
- ▶ Indoor temperatures
 - Ground floor and 1st floor: 23,5° C - 30 °C
 - Top attic: 25,0° C - 32,5 °Cremark: all statements refer to hourly average temperatures
- ▶ Average temperature reduction due to NVC per night
 - Ground floor and 1st floor: ~ 3 - 4° C
 - Top attic: ~ 5° C
- ▶ The higher the decrease of outdoor temperature during the night the more efficient the night cooling

Projekt: Zu-Haus, Auersthal

Qualitatives Monitoring Sommer 2015



Hans Döllinger:

“.....this summer created extremely high temperatures – and created a new challenge for our house: due to our discipline to keep windows and doors closed during the day and due to the Ventilative Cooling system we were able to achieve a reasonable indoor temperature.

Of course the house heated up during the day but it was never inconvenient; we always had the feeling to enter a cool house. In the evening (around 10 pm) the NVC system activated and cooled the house down to outdoor temperature.

All in all we had been very satisfied.”



Components for a NVC System

Motors for inlet air for vertical windows

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**WINDOW
Master®**
Fresh Air. Fresh People.

In general:

- ▶ 24 V-motors
- ▶ for bottom hung or side hung windows
- ▶ suitable for wooden windows, plastic windows, aluminium windows.....

Motor "small":

- ▶ opening width max. 150 mm
- ▶ wide windows: 2 motors synchronous

Motor "large"

- ▶ opening width up to 500 mm
- ▶ wide windows: 2 motors synchronous



Motors for inlet air for vertical windows

VELUX®

**WINDOW
Master®**
Fresh Air. Fresh People.



Power Supply System



**WINDOW
Master®**
Fresh Air. Fresh People.



For max. 2 motors

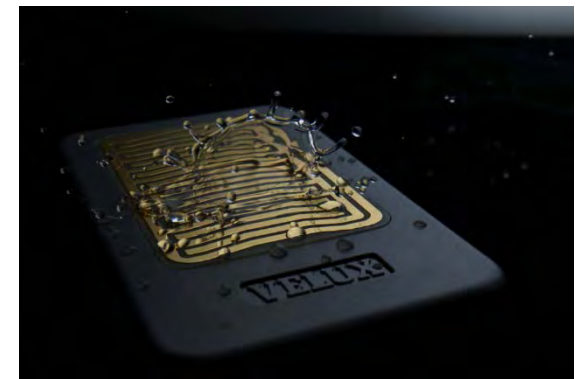
Windows for exhaust air in the roof

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Solution for the sloped roof VELUX INTEGRA



- ▶ Integrated 24 V-motor
- ▶ wireless
- ▶ Motor + control system integrated

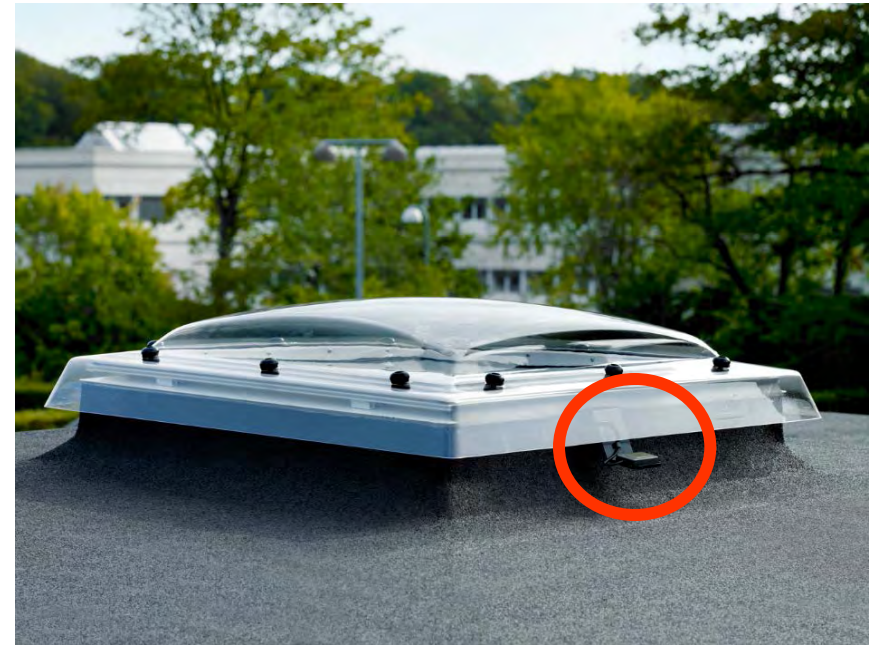
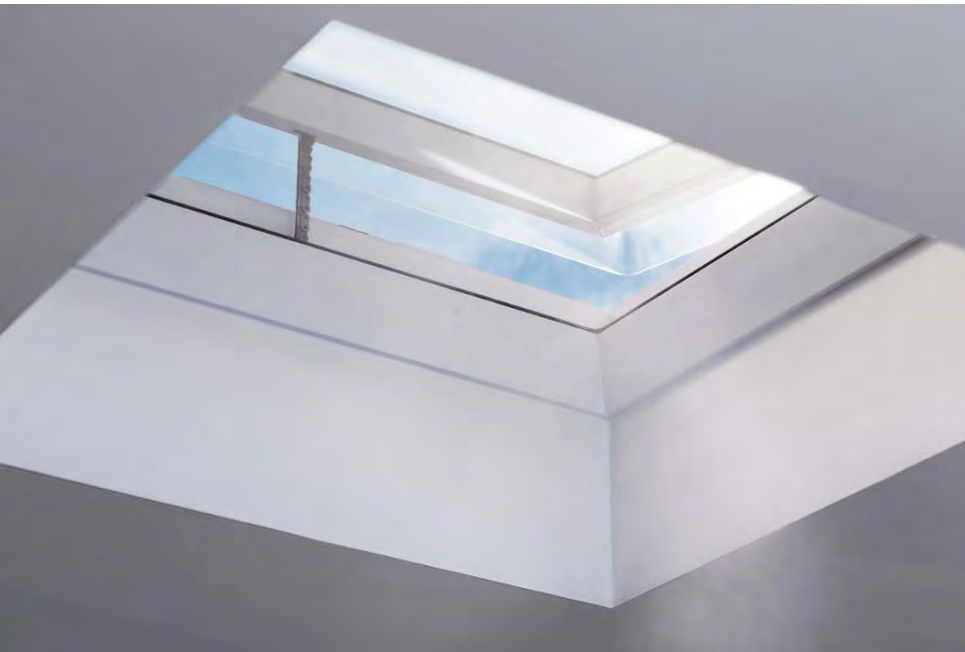


Incl. rain sensor

Windows for exhaust air in the roof



Solution for the flat roof Flat roof window

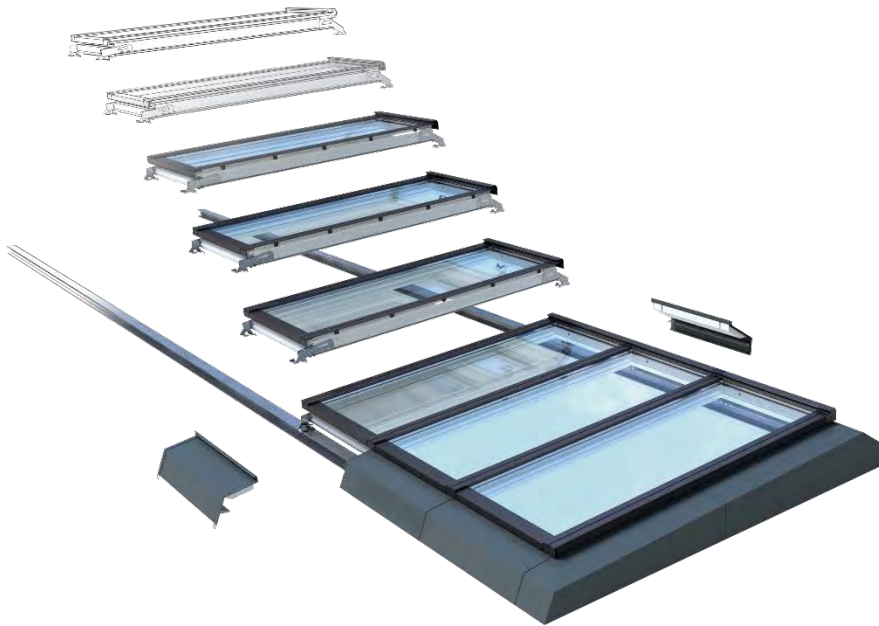


- ▶ Integrated 24 V-motor
- ▶ wireless
- ▶ Motor + control system integrated

Incl. rain sensor

Windows for exhaust air in the roof

Solution for the flat roof Modular Skylight



- ▶ Integrated 24 V-Motor
- ▶ wireless
- ▶ for „free system“ available

Optional:
Central rain sensor



Configuration for a NVC system

Configuration/system control

Natural Ventilative Cooling

Timer controlled

Exhaust air

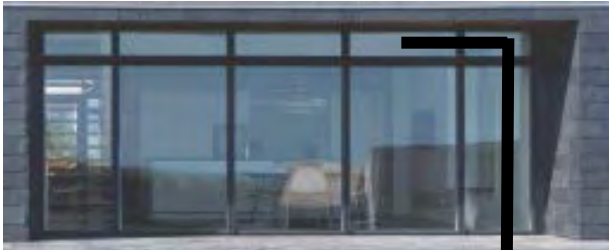
Roof windows with integrated motor and rain sensor



Remote control including timer + manually operation

Inlet air

Motors for vertical windows



Power supply



summer:
Windows open at 10 pm
Windows close at 8 am

Sensor controlled Outdoor temperature



Commercially available outdoor temperature sensors
= standard components

Interface



„Translates“ values of a sensor to the control system

1 Interface for max. 5 areas

Configuration/system control

Natural Ventilative Cooling

Temperature controlled

Exhaust air
Roof windows with integrated motors and rain sensors

Inlet air
Motors for vertical windows



Interface



Outdoor Temperature sensor



Power supply



Remote control (for manual intervention)

summer:
Windows open at 26° C
and close at 21° C



Upgrading to a need based ventilation system

Sensors

CO₂-sensor



Commercially available CO₂-Sensors
= standard components

Ideally with on/off-switch

Interface



„Translates“ values of a sensor to the remote control

1 Interface for max. 5 areas

Configuration/system control

Need based window ventilation

Exhaust air

Roof windows with integrated motors and rain sensors



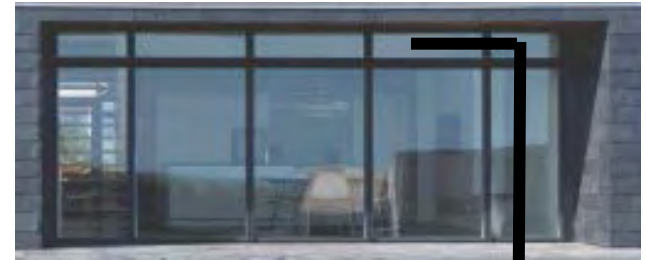
Interface



Remote control
(for manual intervention)

Inlet air

Motors for vertical windows



Power supply



CO₂-Sensor



Option:
on/off switch

Winter and transition periode:
Windows open at 1.000 ppm



Maintenance of NVC system

Maintenance

- ▶ there is absolutely no maintenance
= all components are maintenance free



More projects

Haus T, Herzogenburg, Lower Austria

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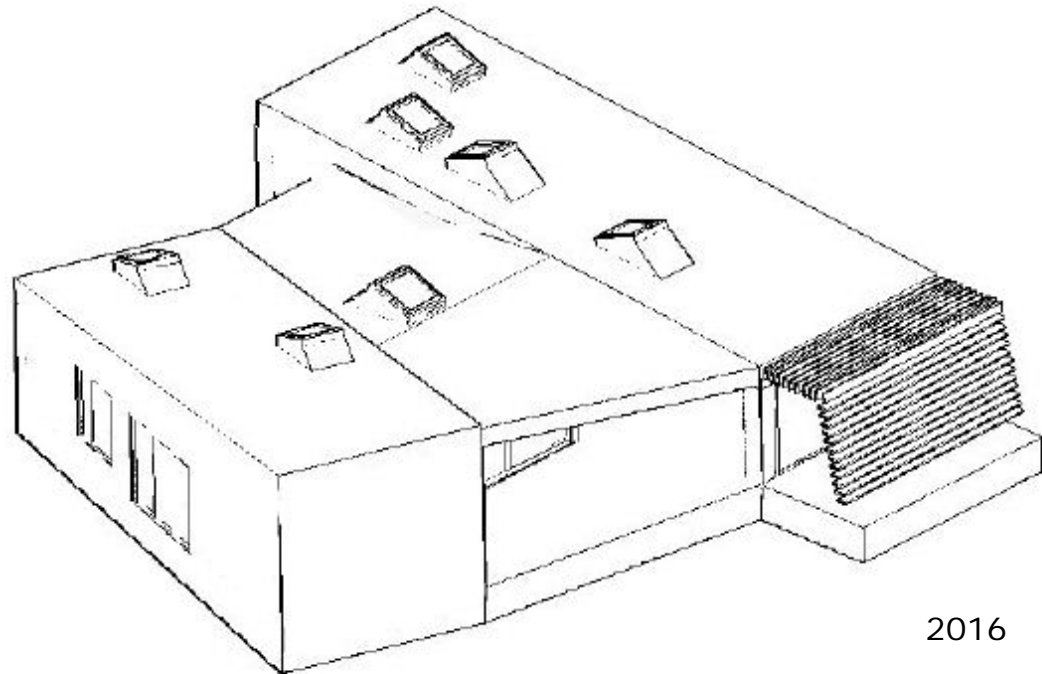
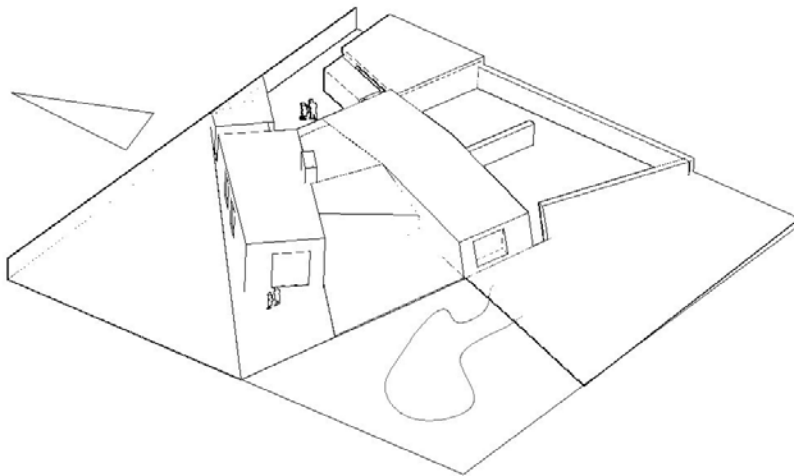
„Hybrid Ventilation“

= mechanical ventilation system

+

Natural Ventilative Cooling

Chalabi Architekten
& Partner



Haus T, Herzogenburg



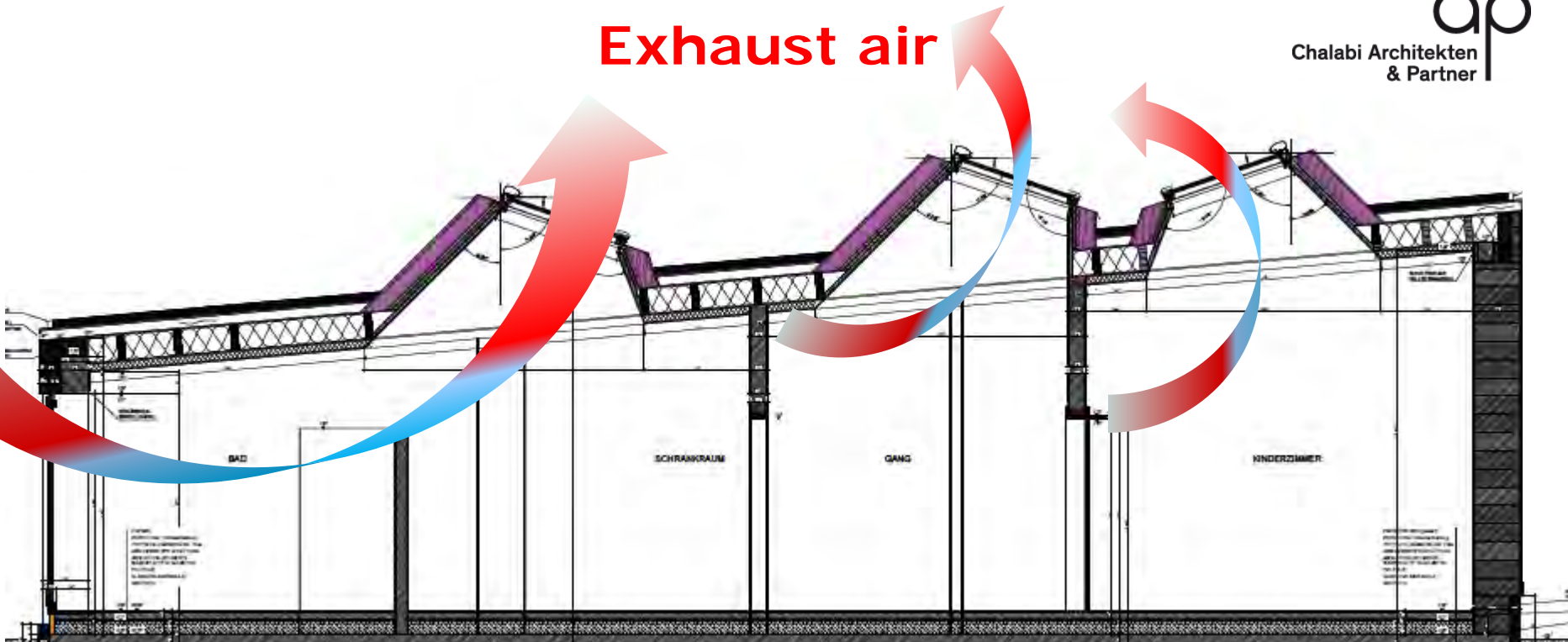
Inlet air

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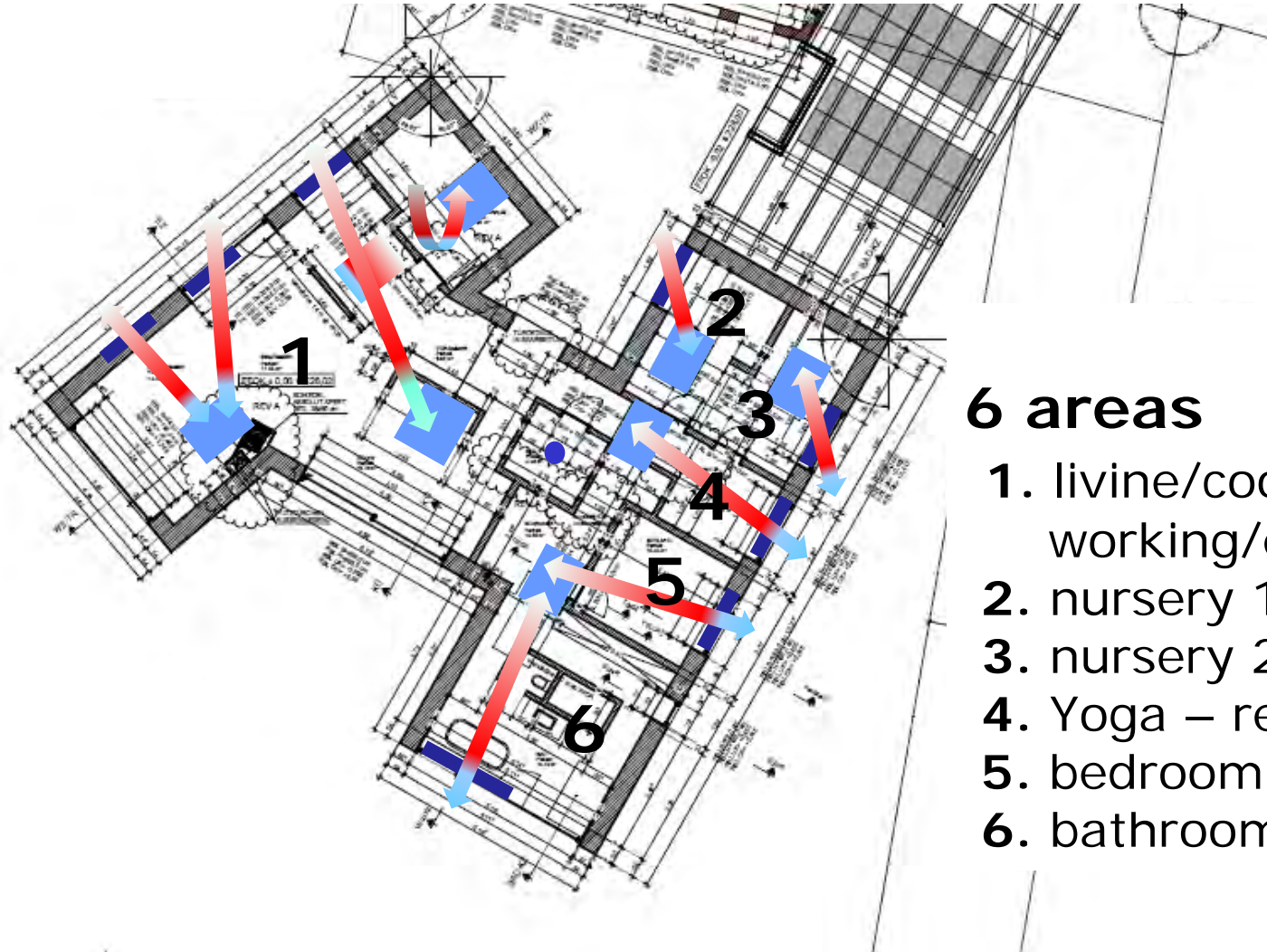
Haus T, Herzogenburg



Exhaust air



Haus T, Herzogenburg



6 areas

1. livine/cooking/eating/
working/entrance – CO₂
2. nursery 1 - CO₂
3. nursery 2 - CO₂
4. Yoga – remote control
5. bedroom - CO₂
6. bathroom – remote control

Haus T, Herzogenburg



Haus T, Herzogenburg



Haus T, Herzogenburg



Haus T, Herzogenburg

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Monitoring

Quantitative monitoring: Start in 2017

- ▶ CO₂-concentration
- ▶ Humidity
- ▶ Room temperature
- ▶ Comparison: open windows vs. closed windows
- ▶ Comparison: Automatically controlled vs. „human handling“

Qualitative monitoring Experience in 2015 and 2016

„Even in summer 2015 we had convenient temperatures in the house. For my feeling it was sometimes even too chilly; then I closed the windows via remote control. There was a problem with the home automation: the heating system switched on due to room temperatures below the set point of 22°C.“

Donau Universität Krems
Department für Bauen und Umwelt



House at the mountain, Vorarlberg



juri troy architects

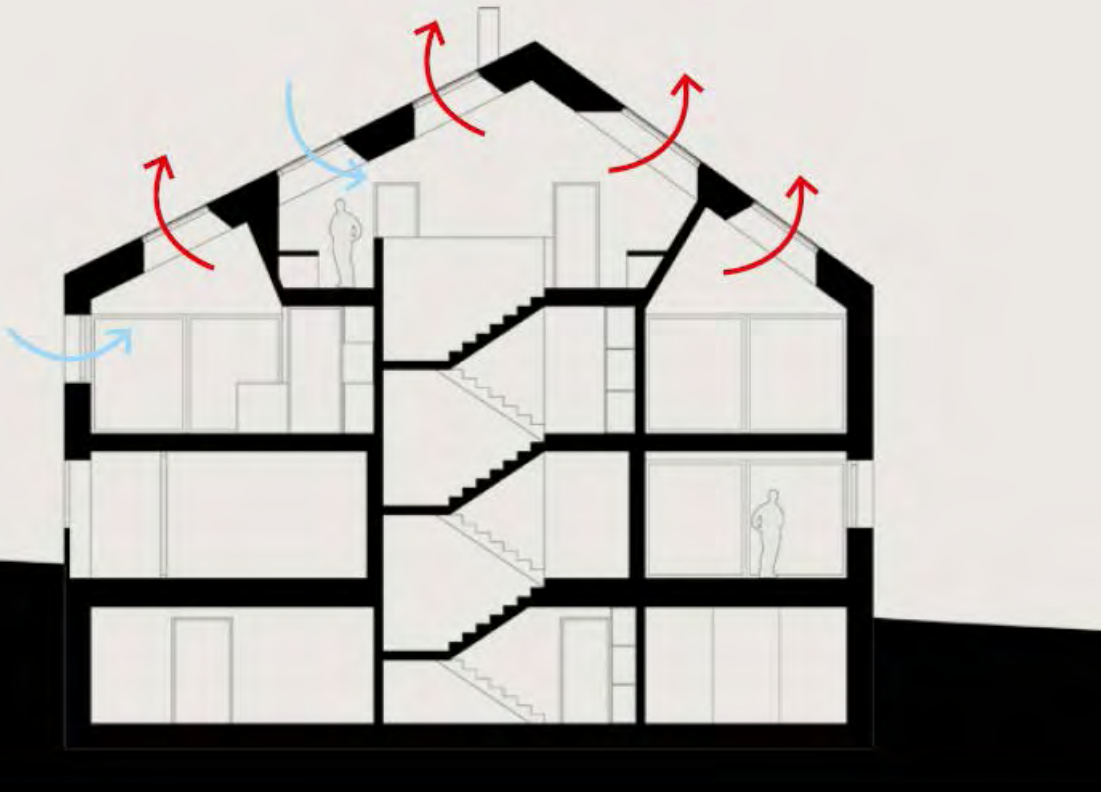


House at the mountain, Vorarlberg

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juri troy architects

Ventilation concept



Automated window ventilation

5 areas

- ▶ master bedroom
- ▶ nursery 1
- ▶ nursery 2
- ▶ living/eating/kitchen
- ▶ gallery

Via remote control

- ▶ bathroom

House at the mountain, Vorarlberg



juri troy architects



House at the mountain, Vorarlberg



juri troy architects



House at the mountain, Vorarlberg

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Projekt: Zu-Haus, Auersthal

Qualitatives Monitoring Sommer 2015



Elmar Fink, owner and master carpenter:

„The system works fine – right from the beginning. When we moved into the house it was unusual that windows open automatically during the night – but we got used to it and definitely do not want to miss it.

The NVC system secures convenient temperatures, even in the extremely hot summer of 2015“.

Natural Ventilative Cooling

Conclusion

- ▶ Natural Ventilative Cooling works
 - In simulation as well as in practice
 - Also controlled as low-tech system
- ▶ Even when outdoor temperature exceeds 35° C: permanent cooling below 27° C possible
- ▶ Cooling of some 5 K during night realistic
 - Extremely efficient for summer indoor comfort
 - Saves huge amount of cooling energy
- ▶ Window positioning extremely important (integral planning)

BUT

- ▶ Not the answer for any situation
- ▶ Not considered in norms/software tools accordingly
- ▶ Not yet well known.....



www.velux.at
www.windowmaster.com

Thank you for your attention!