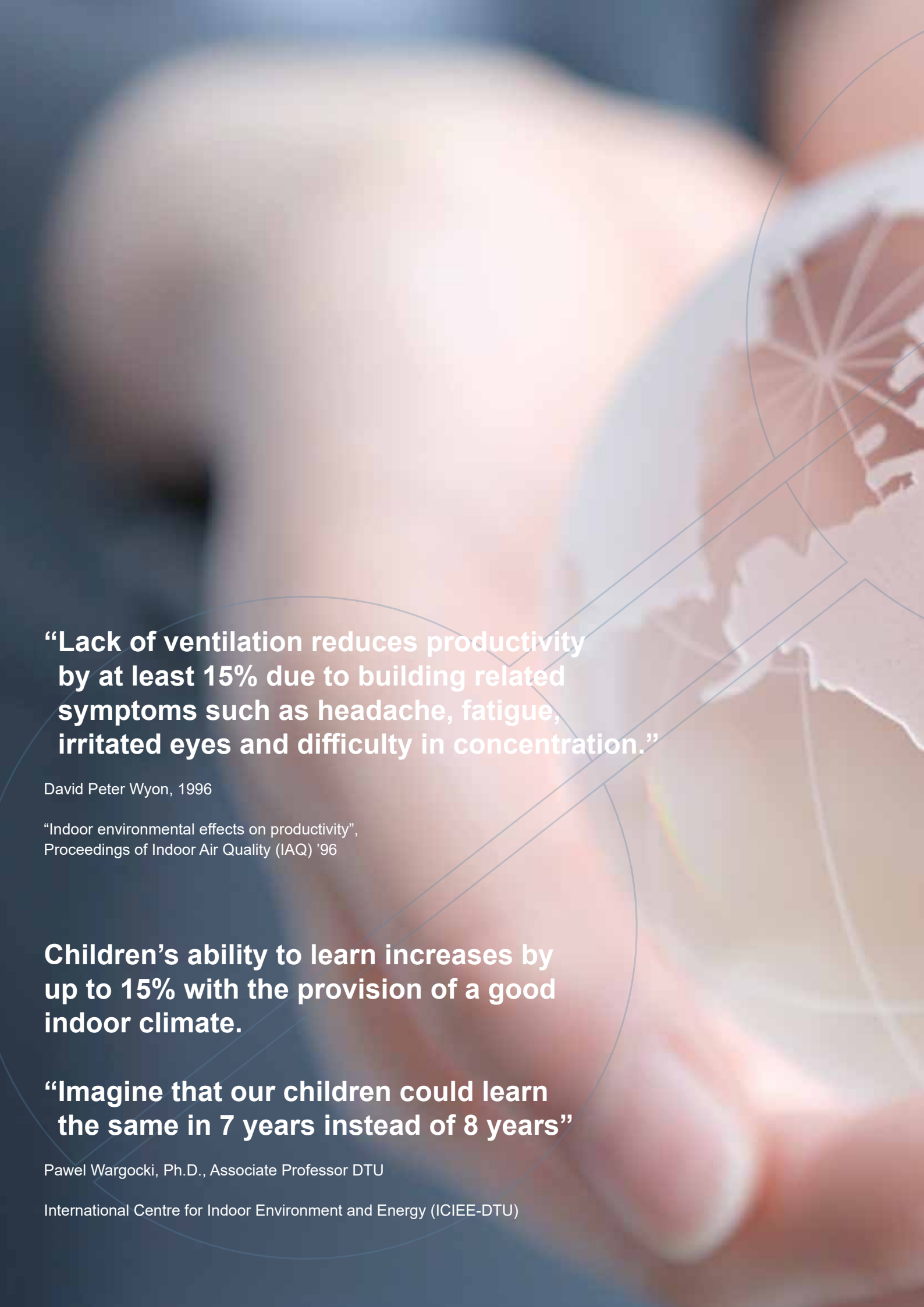


NV Comfort®
**Good indoor climate
based on natural
ventilation**

Indoor climate solutions

NV Comfort® provides an optimum indoor climate in up to 8 ventilation zones based on the automatic opening and closing of windows. It comes with a touch screen panel.





“Lack of ventilation reduces productivity by at least 15% due to building related symptoms such as headache, fatigue, irritated eyes and difficulty in concentration.”

David Peter Wyon, 1996

“Indoor environmental effects on productivity”,
Proceedings of Indoor Air Quality (IAQ) '96

Children’s ability to learn increases by up to 15% with the provision of a good indoor climate.

“Imagine that our children could learn the same in 7 years instead of 8 years”

Pawel Wargocki, Ph.D., Associate Professor DTU

International Centre for Indoor Environment and Energy (ICIEE-DTU)

Good indoor climate with natural ventilation	4
Natural ventilation – a benefit for the environment, architecture and economics	6
Basic ventilation principles	8
Mixed mode ventilation	10
Recommendations for design with natural ventilation	11
NV Comfort®	12
NV Comfort® – the intelligent solution for up to 8 zones	14
Choosing functionality	16
Configuration of a NV Comfort® solution	18
NV Comfort® – a system overview	20
Solution examples	22
Legislation and guidance	24
Smoke ventilation	25
Research and development towards a sustainable indoor climate	26
Selected references	27

Good indoor climate with natural ventilation

International research results show that a good indoor climate is crucial for human well-being, productivity and learning. Research has shown that an increase in productivity of up to 15% can be achieved with a good indoor climate.

WindowMaster and natural ventilation

WindowMaster has delivered solutions for natural ventilation and smoke ventilation to a wide range of buildings across Europe for 25 years. This experience

and knowledge has enabled WindowMaster to continually develop products and solutions to provide an optimal sustainable indoor climate. A result of this development is NV Comfort®.

NV Comfort®

NV Comfort® is a cost effective indoor climate solution based on natural ventilation. NV Comfort® is ideal for small and medium sized buildings such as offices, schools and healthcare facilities, where there is focus



on extremely low CO₂ emissions as well as simple and individual control of the indoor climate in all rooms.

NV Comfort® ensures that façade and roof windows automatically open and close by incremental amounts according to individual fixed values for the desired room temperature and CO₂ level. Measurements of external temperature, rain and wind speed together with the actual levels of room temperature and CO₂ are the basis for controlling the indoor climate.

Learn more

For additional information or documentation after reading this brochure please visit our website

windowmaster.com



Natural ventilation – a benefit for the environment, architecture and economics

40% of the energy consumption in Western Europe is for buildings – energy, which is primarily coal based, thus providing high CO₂ emissions.

It is important to focus on indoor climate solutions that do not consume more electricity, thus producing much more CO₂ than necessary. An indoor climate solution with natural ventilation uses nature's own forces, thermal buoyancy and wind pressure on buildings, and is therefore a more sustainable solution than other more mechanical solutions.

Architecture

Choosing an indoor climate solution with natural ventilation provides the architect with design freedom. A traditional mechanical ventilation system typically occupies 4-7% of the building floor area and 15% of the

building height. The best solution for natural ventilation is achieved when the requirement for fresh air and natural light is planned for in the early design stages.

Economy

Systems based on natural ventilation often have a lower capital cost and have a substantially lower cost to operate than comparable mechanical solutions.





In Western Europe we spend up to 90% of our time indoors, and up to 30% of the building mass does not contribute to a healthy indoor climate. We breathe an average of 12,000 litre of air per day, so the quality of air in the rooms we occupy has significant importance.

A natural ventilation solution, which brings in fresh air through facade and roof windows, will create variations in temperature and air circulation in the room that will make it seem fresher and more invigorating, compared to conventional mechanical solutions.

User satisfaction

Many studies show that satisfaction with the indoor climate is greater in buildings with natural ventilation than in other traditional indoor climate solutions. User satisfaction is also high because the user has the ability to influence how much air is coming in – simply by opening or closing the windows with a keypad.

Doctor Harald W. Meyer and others conducted a study on the symptoms of poor indoor climate, for example irritations of the eyes and ears as well as headaches, fatigue and concentration problems, associated with mould and ventilation type on boys in 8th and 9th grade.

The study clearly shows that the boys have more symptoms in rooms with mechanical ventilation than in rooms with natural ventilation.

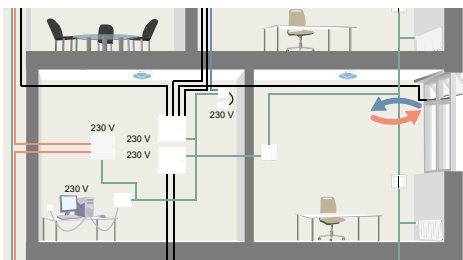
H.W. Meyer, H. Würtz, P. Suadicani, O. Valbjørn, T. Sigsgaard and F. Gyntelberg. 2005.

Mould in floor dust and building-related symptoms amongst adolescent school children: A problem for boys only?
Indoor Air, 15 (suppl 10), 17-24



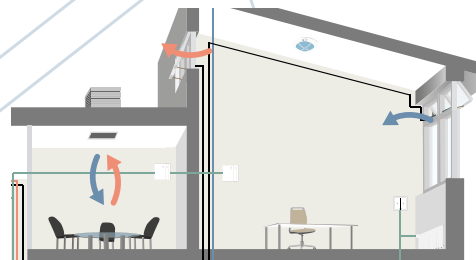
Basic ventilation principles

The driving forces in natural ventilation are thermal buoyancy and wind pressure on buildings. The design of the building, the form of the window openings and location have a significant impact on the quality of the indoor climate



Single-sided ventilation

The windows can only be opened in one side of the room. The amount of fresh air coming into the room is limited by single-sided ventilation. It is recommended that the depth of the room should not exceed 2.5 times the clear height of the room and that the space is not used for high density spaces such as meeting rooms, classrooms or similar.

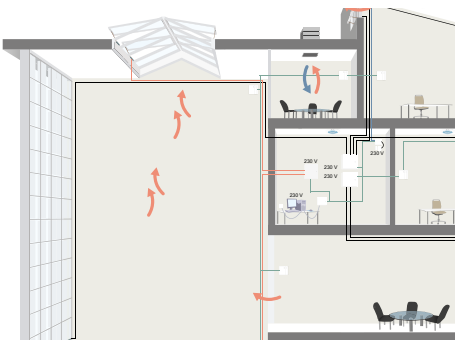


Cross-ventilation

Windows in two or more façades can create cross-ventilation in a room. The ventilation is powered primarily by the wind, which creates differences in wind pressure on the façades in which the window openings are located. As a rule of thumb cross-ventilation can be used effectively when the depth of the room is up to 5 times the clear height of the room.

Choosing the right solution

Our engineers are ready to assist you in finding the right solution for natural ventilation. Through the use of steady state and dynamic analysis, we are able to confirm the suitability of the chosen ventilation principles and provide you with a specific natural ventilation suggestion.



Stack-ventilation

Stack-ventilation occurs when there is a height difference between openings – i.e. between façade and roof windows. This type of ventilation is primarily driven by warm air rising to the top, whereby it creates a pressure difference which drives the ventilation. As a principle rule stack-ventilation can be used effectively when the depth of the room is up to 5 times the clear height of the room. The best effect is obtained when the openings for natural ventilation are placed so that the wind pressure contributes to an increase in the driving pressure.



Mixed mode ventilation

In a number of projects you may choose to install a mixed mode ventilation solution that exploits the advantages of natural ventilation and support these with mechanical ventilation. Natural ventilation is used for most of the year to ensure a flow of fresh air and to cool the building, while the mechanical ventilation – usually with heat recovery – is used in the cold winter months to reduce the heat loss in the building and to pre-heat the fresh air supply. Mixed mode ventilation solutions can come in many different formats.





Mixed mode ventilation

Mixed mode ventilation combines the best of natural and mechanical ventilation into a single solution

Natural ventilation is used for most of the year to ensure a flow of fresh air and to cool the building, while the mechanical ventilation – usually with heat recovery – is used in the cold winter months to reduce the heat loss in the building and to pre-heat the fresh air supply.

Mixed mode ventilation can generally be divided into three different system types:

- Natural ventilation in combination with a central mechanical ventilation system with heat recovery.
- Natural ventilation in combination with one or more room-based decentralised mechanical ventilation systems with heat recovery.
- Natural ventilation supplemented by mechanical extraction.

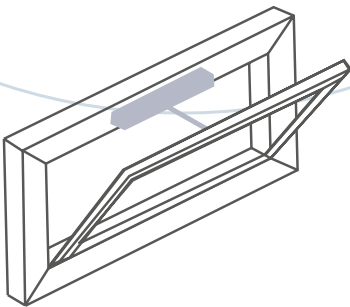
Contractor requirements and the location and shape of the building will decide which of the three system types is right for a specific project or whether a combination of several systems is more suitable.

“Overall economy over a 20-year calculation period shows that the hybrid ventilation solution can be established at the same price as conventional mechanical ventilation solutions. This means that it is possible to reduce ventilation energy consumption without additional investment when the overall economy is viewed over a 20-year period.”

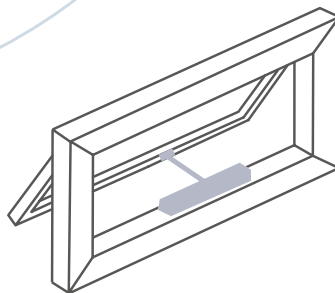
Article in HVAC 6-2009 by WindowMaster and the Engineering College in Aarhus

Recommendations for design with natural ventilation

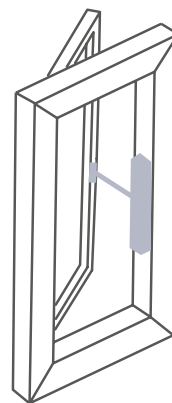
- It is important that the automatically controlled windows are positioned as high within the facade of the space as is possible.
- Experience has shown that it is also important for users to have the facility to locally override the automated openings, via individual switches, when greater or less opening of the windows is desired.
- In buildings with natural ventilation the height of the room should be at least 2.5 m and preferably slightly higher for the best indoor climate.
- The automatic windows should ideally be top-hung outward opening or bottom-hung inward opening and have a height of 400-500 mm.



Bottom-hung inward opening



Top-hung outward opening



Side-hung outward opening

For other types of windows, please contact us

Matching window actuator and profile

Our engineers are happy to provide proposals for concealed, partially concealed or surface mounted solutions. We can provide proposals, for example, for how to customise the window profile to achieve the optimum integrated solution between actuator and profile

It may be possible that the windows can be premounted with WindowMaster MotorLink® actuators and delivered directly from the window manufacturer.

If it is not possible to obtain windows with pre-mounted WindowMaster MotorLink® actuators, then help is available on our website windowmaster.com



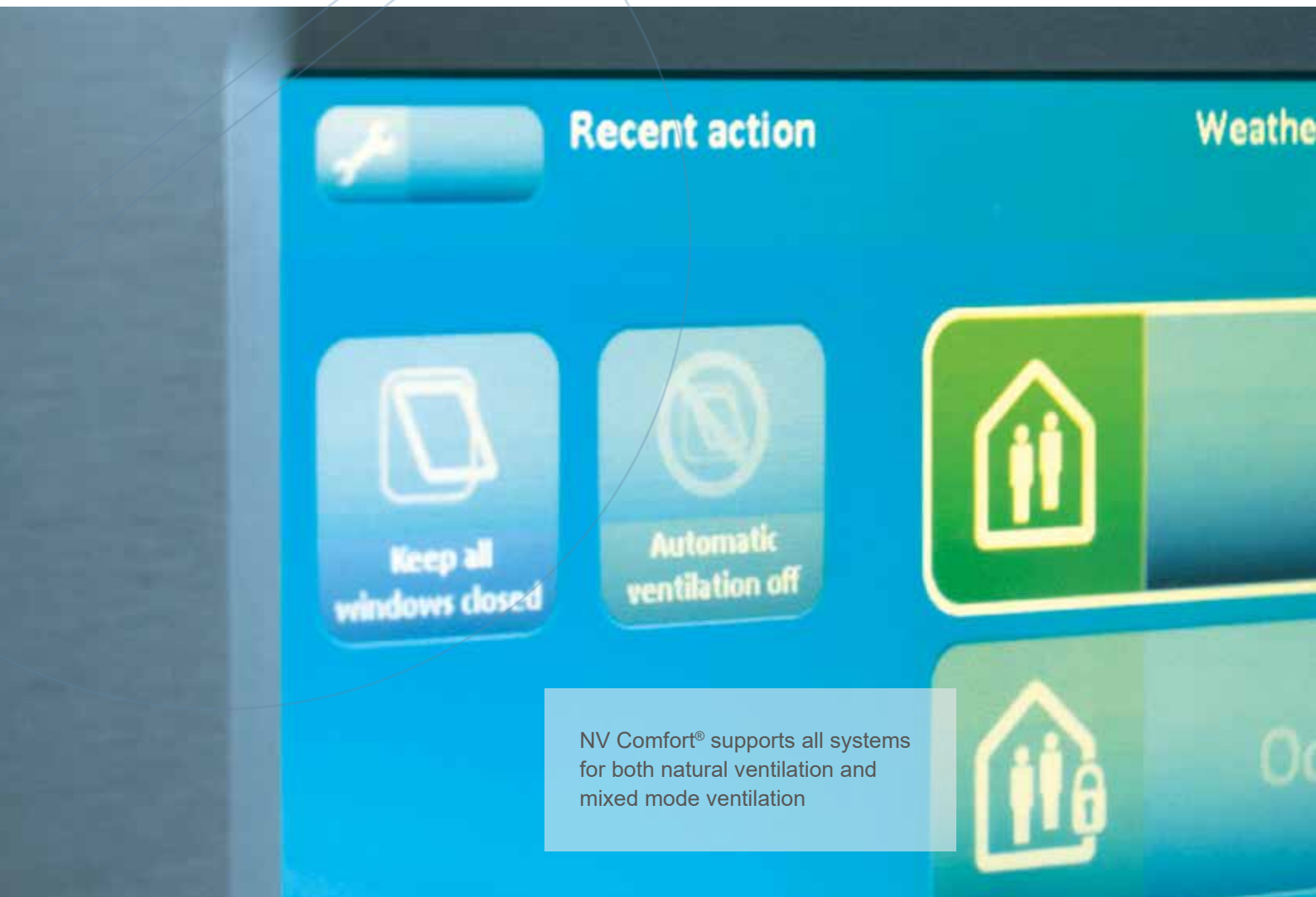
NV Comfort®

A simple indoor climate solution – controls façade and roof windows so that they automatically open and close by incremental amounts on the basis of individual fixed values for the desired room temperature and CO₂ levels, as well as measurements of external temperature, rain and wind speed

All configurations are done via a simple menu on the touchscreen display

Settings of the desired room temperature and CO₂ levels can be done individually for each room from one central location in the building via the NV Comfort® touch screen. At any time the user can open or close the window via a keypad within the room if more or less fresh air is desired. After a pre-defined time, the system will switch back to automatic control.





NV Comfort® supports all systems for both natural ventilation and mixed mode ventilation

The communication with each actuator is via our special patented technology called MotorLink®. This technology is used in NV Comfort® and enables the system to register the opening distance of each window. MotorLink® technology also means that windows can be opened with three different speeds, one slow and soundless speed in automatic control, a quick, audible speed in manual operation and a fast speed by smoke ventilation and security functions.

Window actuators equipped with the special MotorLink® technology can reduce the risk of entrapment. The actuators are programmed to stop and reverse if they encounter obstacles when closing.

Simple installation and implementation

NV Comfort® is a bus-based solution in the very popular KNX standard. This means that it is simple for a trained ETS electrician to install and operate.





NV Comfort® – the intelligent solution for up to 8 zones

In addition to ensuring an optimum indoor climate, NV Comfort® is able to make buildings more energy-efficient. NV Comfort® allows different installations in the building, such as natural ventilation, mechanical ventilation, heat control and sun shades, to be controlled centrally, which achieves a synergy effect among the various functions. The interaction between ventilation, heating and sun shades reduces the building's energy consumption.

Two versions

NV Comfort® is available in two versions; NV Comfort® Standard and NV Comfort® Plus. Both versions are able to control natural ventilation and heating. NV Comfort® Plus is also able to control sun shades, lighting and mechanical ventilation. Which version to choose depends on the requirements and the installations in the building.

“Approximately 3-5 times as much energy is used for cooling as for heating so there is plenty to be saved by using sun shades.”

Nordic Folkecenter for Renewable Energy

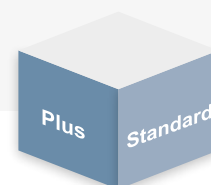
Functions **Standard**

Natural ventilation

A healthy and comfortable indoor climate is ensured through the automatic control of the opening of skylights and façade windows. The size of the window openings and the frequency of opening are configured based on the pre-defined values of the operating parameters for temperature, CO₂ level and humidity compared to the measurements of the outdoor temperature, wind speed and rain from the connected weather station. It is also possible to configure predefined airing times. The system has a built-in safety feature so that the opening of windows is restricted in the event of high wind speeds and the windows are closed in the event of strong wind or rain.

Control of heat

NV Comfort® controls the radiators via KNX thermal actuators so that the heating is turned on or off based on predefined temperature set-points. This ensures a comfortable and stable room temperature during both heating and ventilation periods. NV Comfort® can also be integrated with the building's heating plant.



Functions **Plus** (including standard functions)

Sunlight protection

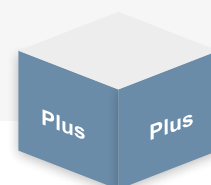
The sun screening function allows venetian blinds, awnings etc. to be controlled automatically, both in summer and winter, so that the position of the sun screening can be continually adapted to the prevailing lighting and heating situation in a room. This allows an optimal use and exploitation of the sun screening product as well as optimising the use of solar thermal energy. The actual control is based on measurements of lux and temperature.

Control of light

By connecting PIR detectors, it is possible to turn off the lighting automatically when a room is vacated, thereby reducing the building's energy consumption.

Mixed mode ventilation

If the number or size of a building's windows is not sufficient to achieve an optimal indoor climate with natural ventilation, external fans (mechanical ventilation) can be connected and used at peak loads.



Choosing functionality

With four different software cards it is possible to choose the right NV Comfort® solution for the specific project in terms of number of zones and functionality. Both NV Comfort® Standard and NV Comfort® Plus are available in versions with 4 and 8 zones.

NV Comfort® functions can be implemented and activated independently of each other to allow project-specific adaptability of the system. An existing NV Comfort® can be upgraded at any time to multiple zones and/or functionalities. Please contact WindowMaster for further information on system upgrades.

Combination options

NV Comfort® must be used in conjunction with WindowMaster MotorLink® window actuators and MotorControllers and keypad, sensors and KNX products – refer to page 22.

For combination with io-homecontrol® products or smoke ventilation, please contact WindowMaster for further information.





Standard 4 zones

- NV Comfort® touch screen with adaptor
- NV Comfort® software card, 4 rooms / zones, Standard
- NV Comfort® basis pack (KNX power supply + weather station)

Natural
ventilation

Heatcontrol

Standard 8 zones

- NV Comfort® touch screen with adaptor
- NV Comfort® software card, 8 rooms / zones, Standard
- NV Comfort® basis pack (KNX power supply + weather station)

Natural
ventilation

Heatcontrol

Plus 4 zones

- NV Comfort® touch screen with adaptor
- NV Comfort® software card, 4 rooms / zones, Plus
- NV Comfort® basis pack (KNX power supply + weather station)

Natural
ventilation

Heatcontrol

Mechanical
ventilation
(mixed mode)

Lightcontrol

Sun
screening

Plus 8 zones

- NV Comfort® touch screen with adaptor
- NV Comfort® software card, 8 rooms / zones, Plus
- NV Comfort® basis pack (KNX power supply + weather station)

Natural
ventilation

Heatcontrol

Mechanical
ventilation
(mixed mode)

Lightcontrol

Sun
screening



Configuration of a NV Comfort® solution

1. Which features

Besides natural ventilation and heating are other functions to be controlled, e.g. mechanical fans, lighting, and sun screening. If not, select NV Comfort® Standard. If so, select NV Comfort® Plus.

2. Number of zones

For 1-4 rooms / zones, select software card for 4 rooms / zones. For more rooms / zones (up to 8) select software card for 8 rooms / zones. When more than 8 rooms / zones, select extra screen / screens and the necessary software cards.

3. Basic package

Select NV Comfort® basic package (KNX power supply + weather station)

4. Number of windows and actuators

Determine the number of windows to be controlled and the number of actuators. For new windows, the window manufacturer may be able to deliver the windows with built-in MotorLink® actuators.

5. Number of MotorControllers

Decide on the number of MotorControllers. One





MotorController can control up to 10 windows in different zones. The distance between the window actuators and the MotorController depends on the cable dimensions, though max. 50m.

6. Number of sensors and keypads

Each zone is equipped with a room sensor (combined temperature, CO₂ and humidity sensor) and, if Plus is selected, possibly also a LUX and a PIR sensor. Each room should also have at least one keypad and preferably one keypad per window or workplace.

7. Other components

If heat, mechanical ventilators, light or sun screening is to be controlled, components for these functions must be selected.



NV Comfort® – a system overview

NV Comfort® is ideal for new buildings and for small and mid-size renovation projects, such as schools, offices, hotels, exhibition buildings, sports halls, etc. Moreover, the system can be extended so that the same touch screen can be used to control blinds, lighting, mechanical ventilation and heating.

The illustration below shows how the NV Comfort® solution can be compiled for a school.

School with mixed mode ventilation

The school building consists of five classrooms with mixed mode ventilation and one staff room. Each classroom has four or six windows, each equipped with one actuator, and the window in the staff room is equipped with two actuators.

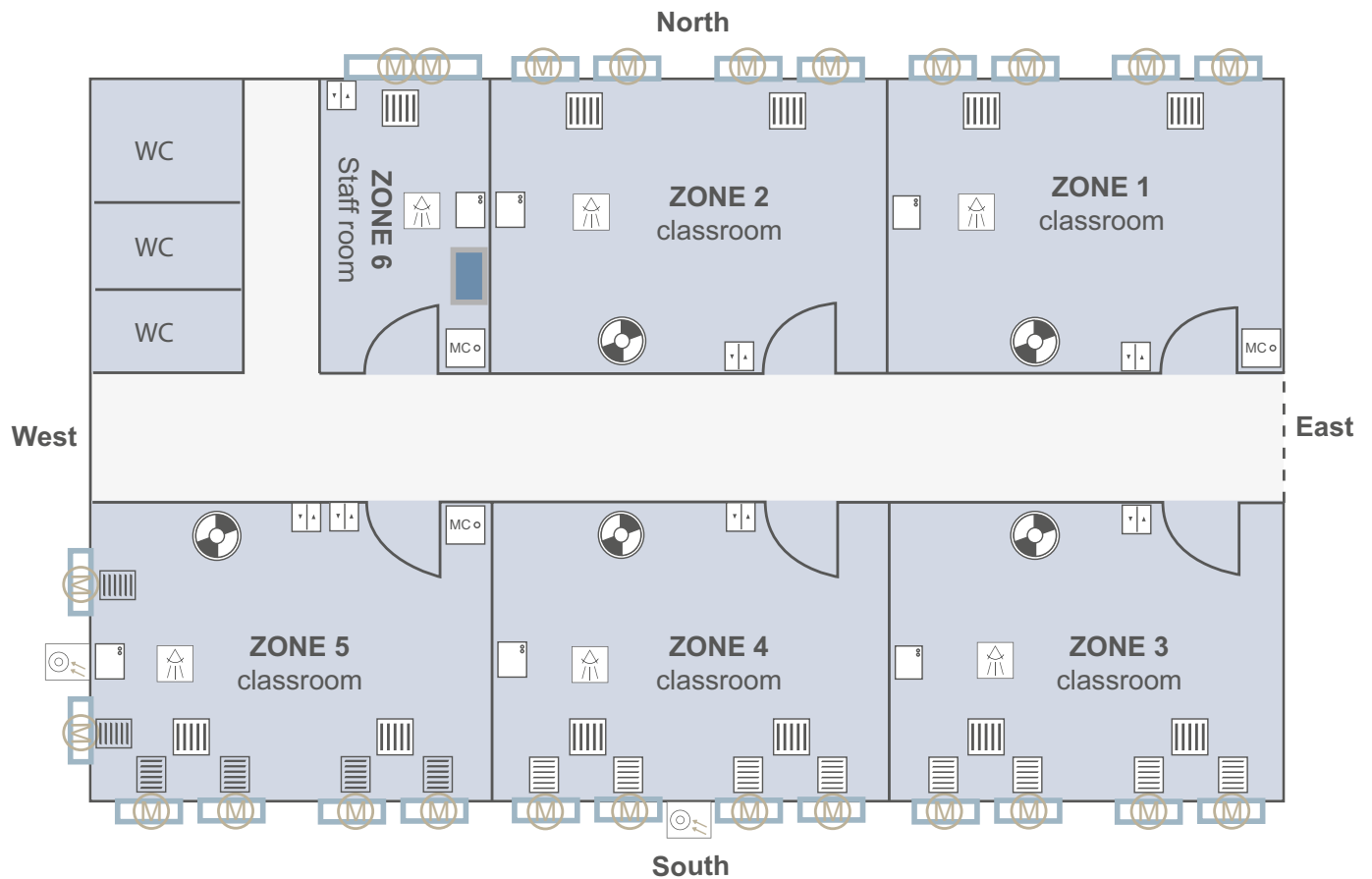
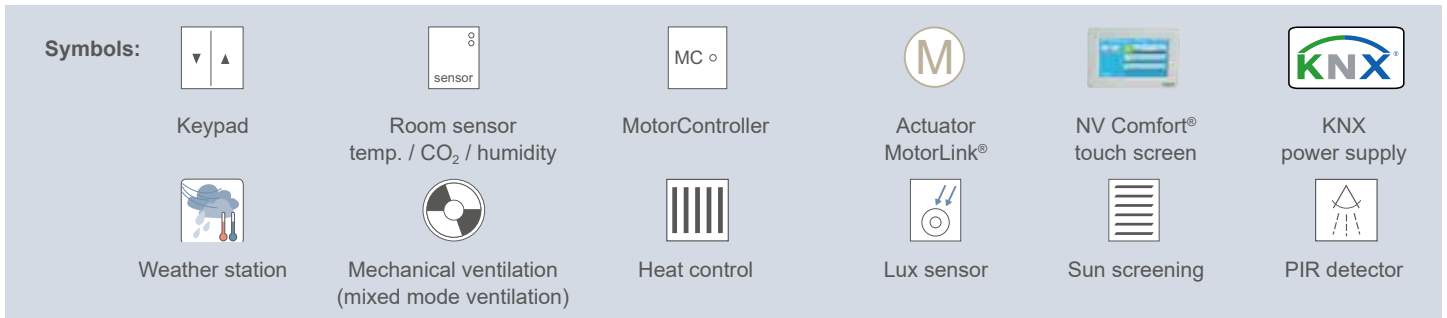
The windows in classrooms 3, 4 and 5 also have sun screens. Each room is fitted with one keypad, one room sensor (temp. / CO₂ / humidity) and one PIR detector.

Classrooms 4 and 5 are also fitted with one LUX sensor. The NV Comfort® screen is placed in the staff room.

The following components have been used:

- 1 x NV Comfort® touch screen with adaptor – NVC KNX A02
- 1 x NV Comfort® software card, 8 rooms / zones, Plus – NVC SC 8P 0
- 1 x NV Comfort® basic package – NVC BP KNX 11
- 22 x actuators, single
- 2 x actuators, syncro
- 2 x MotorController – WCC 320 S 0810 KNX
- 1 x MotorController – WCC 320 P 1012
- 1 x Fieldbus cart – WCA 3FK
- 6 x room sensor (temp. / CO₂ / humidity) – WET 112
- 6 x PIR detector, ceiling – WEO 120
- 6 x keypad, operation of a single window group
- 3 x keypad, operation of a double window group
- 2 x lux sensor – WEL 100
- 1 x sun screening actuator, 8 channels – WEA 250 0802
- 1 x thermo actuator for 12 radiators – WEV 112
- 12 x thermo valve actuator – WEV 113
- 12 x valve adaptor – WEV 114
- 1 x output module for the mechanical ventilation – WEA 165





System example

NV Comfort® can be connected to a number of components so that the control can be adapted to the specific project. An example is shown here with one zone and component connections

1. NV Comfort® touch screen

The touch screen is fitted on the wall and gives the user access to the settings for the individual room temperature and CO₂ levels, as well as the other available control settings.

2. NV Comfort® basic package

The NV Comfort® basic package consists of a KNX power supply and a weather station, which is placed strategically on the outside of the building and collects climate information on temperature, rainfall and wind speed.

3. NV Comfort® software card

With four different software cards it is possible to choose the correct NV Comfort® solution for the specific project in terms of number of zones and functionality.

4. Actuators

Our actuators are available in a wide range of models and sizes and can in some cases be concealed in the window profile. The product catalogue contains both chain and spindle actuators with a stroke of 100-1000 mm which can be programmed for each window. The actuators include the MotorLink® technology.

5. Controls – comfort ventilation

The window actuators open and close automatically with millimetre precision via a signal from the MotorController which uses the unique MotorLink® technology. The controller is available in various models for different numbers of motor lines.

6. Controls – smoke ventilation

WindowMasters smoke control panels can control the combination of comfort and smoke ventilation. Small and medium sized buildings use compact panels, while the modular panels are designed for larger buildings. Both types can be configured into master-/slave-combinations.

7. Sensors

Each climate zone has a sensor measuring the room temperature, CO₂ level and humidity to ensure that the indoor climate is continuously regulated. A PIR detector can also be installed so that the system is able to register any activity in the zone.

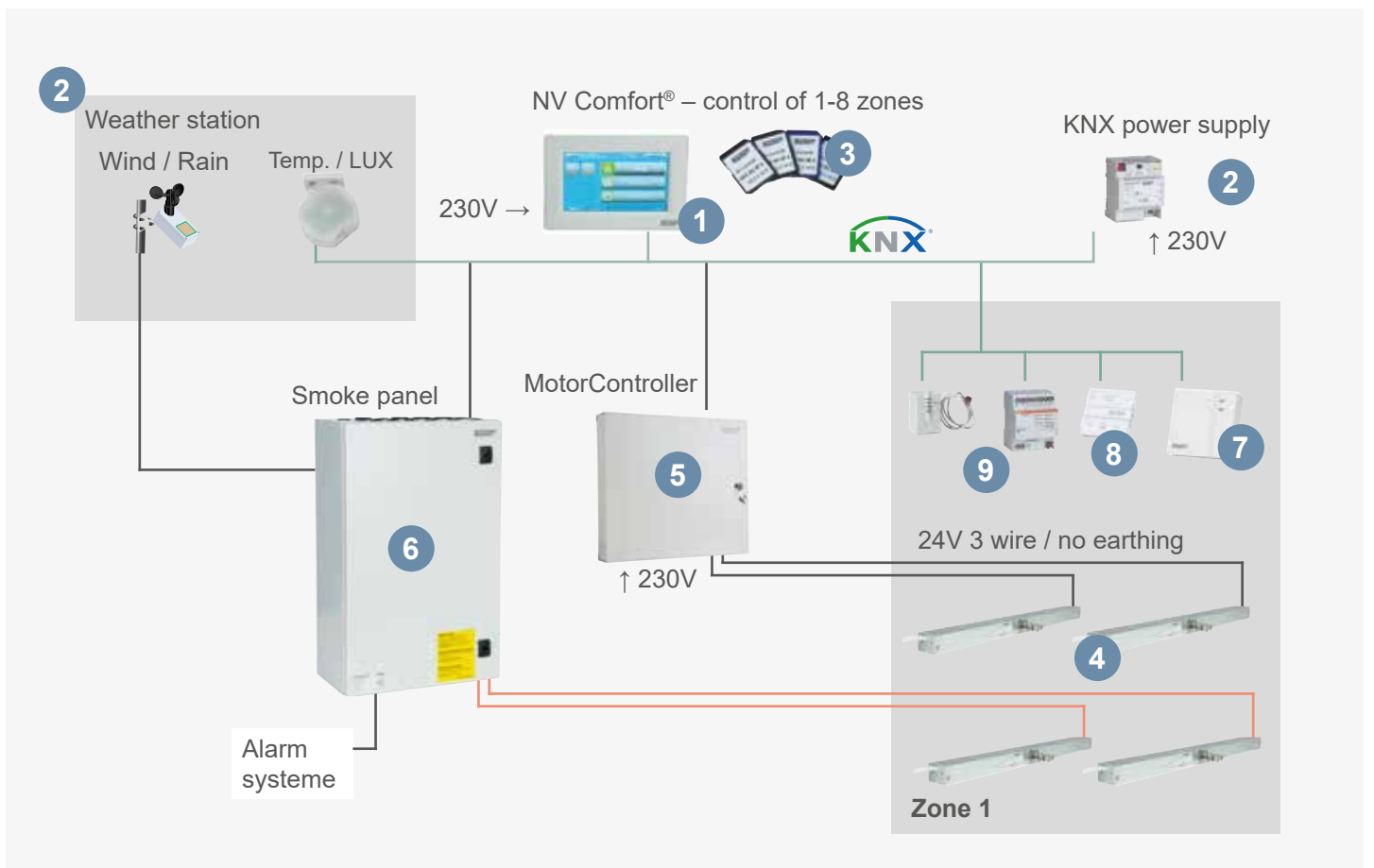
8. Keypads

A keypad (switch) on the wall enables the user to temporarily override the system manually, e.g. to open/close the windows. The keypads can also be linked to other functions such as sun screening.

9. Accessories

WindowMaster also supplies various optional extras for the system such as components for heating control, mechanical ventilation and sun screening.







Legislation and guidance

The legal requirements for indoor climate in buildings appear in the current building regulations.

The Chartered Institution of Building Services Engineers also publish guidance in Application Manual 10 (AM10) titled 'Natural Ventilation in Non-Domestic Buildings'.

Smoke ventilation

For some buildings there is a statutory requirement for installation of smoke ventilation solutions based on automatic opening or closing of specific windows to ensure that people are able to escape the building safely

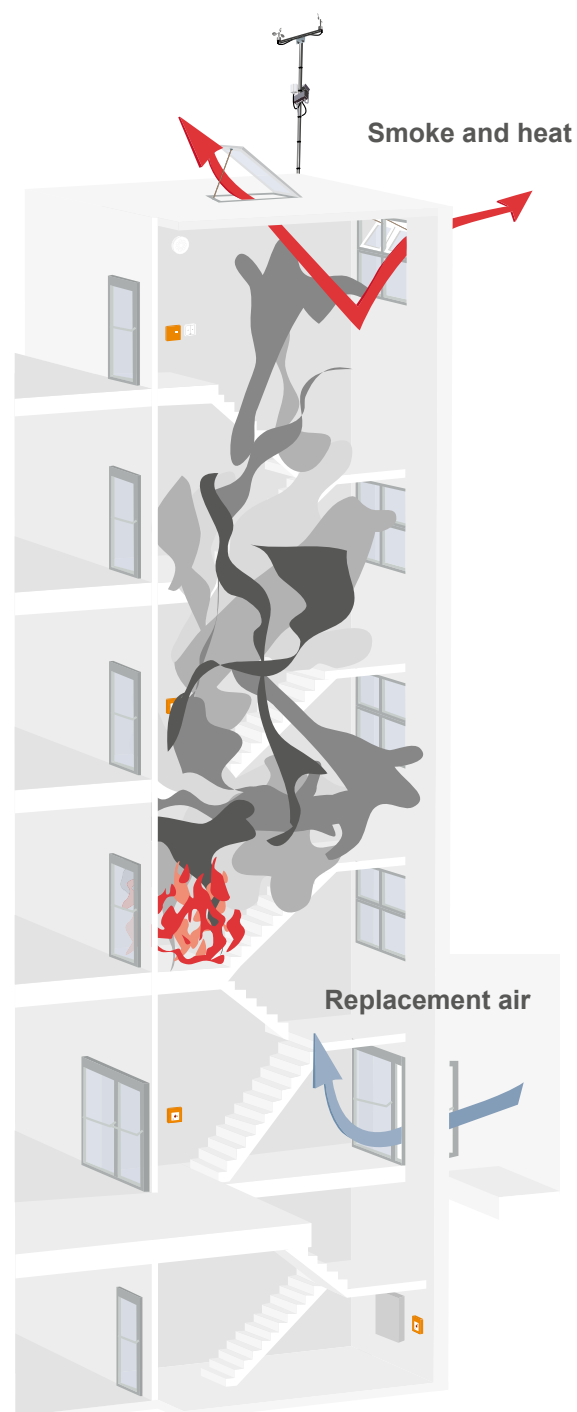
An NV Comfort® solution can also be expanded to include smoke ventilation, including modular smoke ventilation panels, smoke detectors and break glass units. When the smoke ventilation is activated, e.g. using break glass units or smoke detectors, all current NV Comfort® settings – manual as well as automatic settings – are overridden, and all windows connected to the smoke ventilation are immediately opened or closed.

By combining natural ventilation with smoke ventilation, an optimum use of the system is achieved. This is also a financially attractive solution.

Legislation

It is important to note that different countries and governing authorities have differing requirements for smoke ventilation in various building types. These requirements depend on whether the building is a new-build or renovation and apply to product choice, installation and subsequent inspection and testing.

WindowMaster has comprehensive experience in providing expert advice in the design, installation and servicing of smoke ventilation solutions. We have worked with a wide range of window and facade manufacturers to develop, test and certify solutions that meet the latest requirements laid down in European standard EN 12101-2.



Research and development towards a sustainable indoor climate

During the past 15 years WindowMaster has worked closely together with schools, universities and research institutions on the development and optimisation of indoor climate solutions based on natural ventilation and mixed mode ventilation.

Selected research projects



Aalborg University, in collaboration with WindowMaster, developed a number of basic principles, algorithms and parameters for optimal control of natural ventilation. Aalborg University and WindowMaster have carried out a series of tests and analysis of air movement around windows to determine the influence of the window location in the facade on the indoor climate.



The Engineering College of Aarhus has, in collaboration with WindowMaster, analyzed the energy consumption, investment and operating costs for typical office buildings. The analysis is done for a number of different types of indoor climate solutions – natural ventilation and mechanical ventilation.



The Alexandra Institute and the Engineering College in Aarhus have carried out a research project supported by EBST entitled "Minimum Configuration – Home Automation" in collaboration with several companies including WindowMaster. The project focuses particularly on user involvement and innovation concerning automatic control devices in homes to achieve energy savings.



In collaboration with the International Center for Indoor Environment and Energy at the Technical University of Denmark, WindowMaster has supported a three-year Ph.D. project 'Occupant behavior with regard to control of the indoor environment'. The purpose of the project has been to study and analyse the users' perception of indoor climate.



The Technological Institute in Copenhagen has, in collaboration with WindowMaster, conducted life cycle analysis for different indoor climate solutions – natural ventilation, mixed mode ventilation and mechanical ventilation. Based on the analysis, an evaluation has been made as to which solution in total has the smallest environmental impact related to production, installation, operation and disposal.

The collaboration with various institutions contributes valuable knowledge about user needs, user behavior, users' perception of a good indoor climate, software, life cycle analysis and much more. Elements which, together with a dedicated effort by our own development department, have made it possible to create products and solutions that ensure a good indoor climate using the fewest possible resources.





Kragelundskolen

Building type : School

Architect : Aarhus Kommune

Solution : Natural ventilation
and mixed mode
ventilation



Tornbjerg børnecenter

Building type : Day care center

Architect : Frede Nielsens
Tegnestue

Solution : Natural ventilation,
mixed mode
ventilation and
heating



Trekronergade Freinet Skolen

Building type : School

Architect : FORMAT arkitekter
og konstruktører

Solution : Natural ventilation



McFit

Building type : Fitness studio

Architect : McFit

Solution : Natural ventilation



WindowMaster aspires to protect people and the environment by creating a healthy and safe indoor climate, automatically ventilating spaces with fresh air through facade and roof windows in commercial buildings. We offer the construction industry foresighted, flexible and intelligent window actuators and control systems for natural ventilation, mixed mode ventilation and smoke ventilation – of the highest quality.

WindowMaster employs around 135 highly experienced cleantech specialists in Denmark, Norway, Germany, United Kingdom, Ireland, Switzerland and United States of America. In addition, we work with a vast network of certified partners. With our extensive expertise built up since 1990, WindowMaster is ready to help the construction industry meet its green obligations and achieve their architectural and technical ambitions.

NV Comfort® is an indoor climate control solution which benefits from WindowMaster's many years of experience with natural ventilation, mixed mode ventilation and window automation.

NV Comfort® is extremely well suited for both new buildings and renovation of small and medium sized buildings, for example schools, offices, surgeries, hotels, exhibition buildings and sports centres.

windowmaster.com