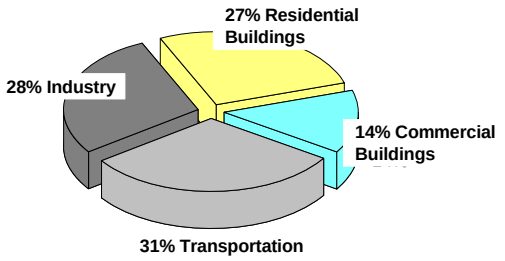
Up to 70 % Energy Savings Achieved in Offices Applying MOS Gas Sensor Technology for DCV

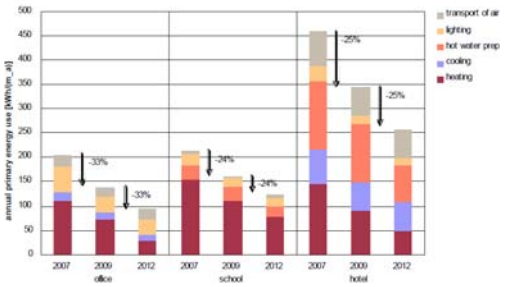
There is tremendous potential for energy conservation in the building sector. Buildings consume more than 40 percent of primary energy in the EU. Two thirds of that energy is used in residential buildings and one third in commercial buildings. The share of energy used for heating and ventilation is roughly two thirds of all energy delivered for buildings. About ten percent of all primary energy is used for ventilation.



Primary energy consumption in the EU[1]

To promote energy-efficient buildings, the European Parliament adopted the European Directive on Energy Performance of Buildings (EPBD) in 2002 and requested the EU Member States to set up minimum requirements on the energy performance of new and renovated buildings. In 2009, the German Energy Conservation Regulation (EnEV, or Energie-einsparverordnung), requires that all new buildings not exceed the maximum value of primary energy demand, depending on the type of building, For example, to prevent heat losses from leakages in the building envelope, the design value for the air tightness of passive houses (residential) is $n_{50} \leq 0{,}60/h$.

Since transmission heat losses are optimized, the role of ventilation is steadily increasing, compared to other elements of the heat balance of a building. Primary annual energy demand of today's office buildings ranges from 120-200 kWh/ (m_a). Consequently, energy-efficient ventilation technologies and strategies providing adequate healthy and comfortable indoor air quality (IAQ) have recently become a major task of building performance. These efforts are supported by the German State within the framework of the second economic stimulus package for schools, kindergartens and private homes.



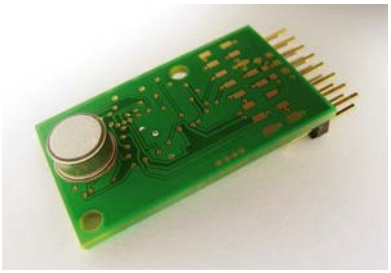
Maximum values of primary energy demand for different building types according to the German energy regulations[2]

Studies have shown that buildings with low energy consumption have a lower rate of building-related symptoms and better IAQ, which can be related to fewer sick leaves and better productivity of pupils and office workers. Therefore, measures to improve IAQ are cost effective, insuring a short payback time, considering potential benefits of reduced sick leave, reduced medical costs and better performance at work gained from improved IAQ.[1]

Epidemiological studies show that ventilation rates below 0.5 ach (air change per hour) pose a health risk in residential buildings. The World Health Organization

stated that indoor air is often more polluted than the corresponding outdoor setting, [3, 4] Not only health problems, such as asthma or allergies, but also comfort complaints and lower productivity are attributed to poor IAQ and inadequate ventilation. The costs associated with poor IAQ, such as the cost of increased sick leave by employees, may even exceed heating energy costs of the corresponding building.

Applying demand controlled ventilation (DCV) in buildings, including using sensors for IAQ control that offer variable airflow rates adapted to the actual load conditions, will fulfill the requirements of adequate IAQ while further reducing energy consumption. For example, heat losses due to uncontrolled window opening or over ventilation of rooms will be avoided.



iAQ-2000 Indoor Air Quality Module

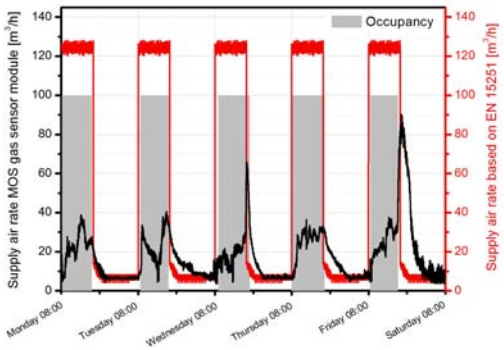
Volatile organic compound (VOC) detection using broad-band sensing of metal oxide semiconductor (MOS) gas sensors has been shown to be advantageous for occupancy-related IAQ monitoring, thus offering a better correlation to perceived air quality than CO_2 quantification. MOS gas sensors can also detect gases considered indoor and outdoor pollutants, including CO, NO_2 and aromatic compounds.

Survey on energy saving potential of the iAQ-2000 sensor module in an office

Investigations into the energy-saving potential of the AppliedSensor iAQ-2000 Indoor Air Quality Module in an 80m³ office with two employees showed that the *supply air rate* was *reduced by approximately 60 percent,* applying the module for IAQ control and trigger for the supply air rate (from 6 m³/h to 125 m³/h in linear scale), compared to the calculated design supply air rate of 125 m³/h for 10 hours per day (6 m³/h for the rest of the day), according to DIN EN 15251 standard based on two people in a low-polluting office. [5]

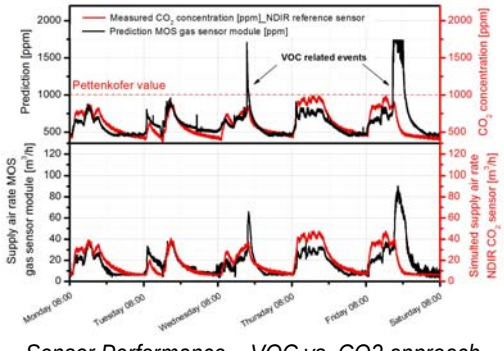
A lower air-change rate has also been linked to power consumption of the fan, resulting in *70 percent less power consumption for DCV*. Moreover, the lower air change rate can be related to lower heating energy demand for the supply air.

Only ventilation based on IAQ control ensures that fresh air is supplied to the room whenever necessary and is automatically adjusted for varying pollution loads stemming from changes in room occupancy. Time control of the ventilation system will apply a constant supply air volume rate and may result in over ventilation of the room, since there is no correlation between occupancy and operation time of the ventilation system.



DCV vs. ventilation according to EN 15251

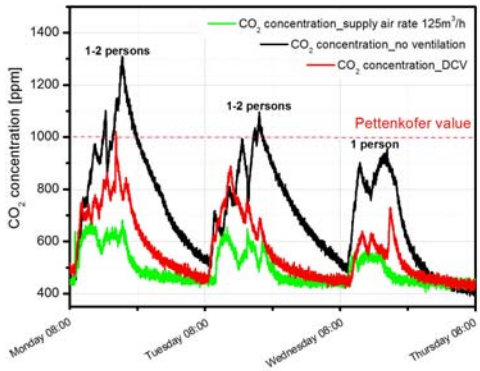
Output signal in CO_2 equivalents [ppm] assures that energy demand for DCV is not necessarily higher using the iAQ-2000 Module compared to DCV based on CO_2 quantification.



Sensor Performance – VOC vs. CO2 approach

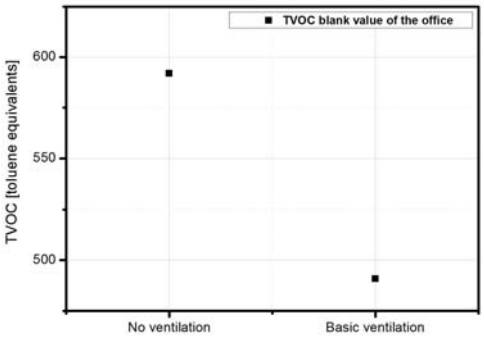
Simulations with CO_2 NDIR reference sensors applying the same ventilation settings as the iAQ-2000 Module showed that ±20 percent supply air rate is needed for both sensing technologies. In the case of higher energy demand of the iAQ-2000 Module, the additional information on air quality provided simultaneously may correlate with perceived air quality. Detection of VOCs and odorous compounds in real-time that can be related to perceived air quality rather than CO_2 is only possible with the MOS gas sensor module.

CO_2 concentrations in the office have been measured and compared for: (1) no ventilation, (2) supply air rate of 125 m³/h and (3) DCV using the iAQ-2000 Module. For equal load conditions of the office (i.e. two people for eight hours a day), the measured CO_2 concentration for DCV is in-between the concentrations obtained for no ventilation and ventilation according to EN 15251 (125 m³/h), (i.e. in the hygienic range of less than the Pettenkofer limit of 1000 ppm CO_2.) Occupancy behavior showed that with natural ventilation, attendees ventilate the office once or twice per day. Especially during wintertime, opening windows may result in significant heat losses.



CO_2 concentrations in the office for no ventilation, supply air rate of 125 m³/h and DCV

A basic ventilation rate as recommended in the EN 15251 Standard according to the building type is necessary for diluting pollution emissions of building materials and office equipment. Total volatile organic compound (TVOC) content has been estimated for the empty office without basic ventilation and for a basic ventilation rate of six m³/h, resulting in 20 percent less pollution from interior sources.



TVOC content in the empty office (blank value) in the case of no ventilation and for a basic ventilation rate of 6 m³/h

The iAQ-2000 Module offers improved perceived air quality adapted to the actual load conditions in real-time, without over ventilating the room, and while minimizing the energy consumption. Applying DCV provides further reduces energy and power consumption demand in office buildings. Extrapolation of the energy saving gained for a single office to a whole office building would be significant.

References:

[1] Seppänen, O. 2008. Scientific basis for design of ventilation for health, productivity and good energy efficiency. In Indoor Air 2008: Proceedings of the 11th International Conference on Indoor Air Quality and Climate. Indoor Air 2008, Copenhagen, Denmark, 2008, paper ID: 744.

[2] Hauser, G. Trends in High-performance Buildings and the Role of ventilation. Proceedings of the 30th AIVC Conference. Berlin, Germany, 2009.

[3] Wargocki, W. et al. 2002a. Ventilation and health in non-industrial indoor environments.Report from a Euro-pean Multidisciplinary Scientific Consensus Meeting. International Journal of Indoor Environment and Health. Vol.12:113-128.

[4] WHO - World Health Organization. www.who.int

[5] EN 15251. 2007. Indoor environmental input para-meters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics. European Committee for Standardization, Brussels, Belgium.

About AppliedSensor

Relying on 25 years of research and development, AppliedSensor designs and manufacturers chemical sensor systems for a broad range of applications, including IAQ, modules and hydrogen leak sensors for fuel cell vehicles. The company operates three facilities worldwide: AppliedSensor GmbH in Reutlingen, Germany; AppliedSensor Sweden AB in Linköping, Sweden; and AppliedSensor, Inc. in Warren, New Jersey. For more information, email info@appliedsensor.com or visit www.appliedsensor.com.