NORDIC KNOW-HOW 2020

BEST PRACTICES OF SUSTAINABLE HEALTHCARE IN THE NORDICS

REPORT SERIES BY NORDIC CENTER FOR SUSTAINABLE HEALTHCARE

#4 VENTILATION

INTRODUCTION

Climate change is one of the greatest environmental challenges faced by societies today and action must be taken from a wide range of sectors – healthcare being no exception. A recent study estimates that the climate footprint of the healthcare sector is equivalent to 4.4% of global net emissions (HCWH, 2019).

Nordic sustainable healthcare is considered to be in the forefront in a global context (Eriksson et al, 2019). Sustainability within healthcare has a long tradition in the Nordics and there are many good examples of best practices.

The aim of this Nordic Know-How report series is to spread knowledge and examples of best practices to international actors in the field of sustainable healthcare.

The theme of this fourth report in the Nordic Know-How series is sustainable **ventilation** in healthcare. With the right knowledge and equipment ventilation can be energy efficient, contribute to lower risk of infection and a better working environment. This report provides good examples from Swedish municipal regions and hospitals on the topic of sustainable ventilation.

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#4 VENTILATION
Report series by
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ABOUT VENTILATION IN HEALTHCARE

Healthcare facilities set high demands when it comes to the right ventilation for the right purpose. Hospitals are in operation around the clock and high-performance ventilation is crucial in order to avoid spread of infections and reduce exposure to contaminants.

The ventilation requirements in for example waiting rooms are very different from the ventilation necessary in operating rooms. The ventilation required in facilities with high demands for hygiene are often extremely energy demanding, mainly because the airflow is usually 20-40 times that of regular housing ventilation and with much greater area. Ventilation is one of the biggest contributors to the energy use in hospitals. Hence, there is an enormous capacity for energy savings (Energimyndigheten, 2020; Löndahl, et al. 2017).

ENVIRONMENTAL IMPACTS

As mentioned above, high performance ventilation is extremely energy demanding. For example, in an operating room, ventilation can require between 25 000 and 35 000 kWh/year. A normal-sized hospital has between 20-40 operating rooms, as well as adjoining spaces that requires clean air (Löndahl, et al. 2017).

The maintenance of the ventilation system is central in order to optimize function and keep the energy use on a low level. A ventilation system that prevents the spread of infections can also contribute to a lower energy use, as infections prolong care, often adding at least a year. This means there are good opportunities to save energy, reducing both the costs and environmental impact of the hospital (Löndahl, et al. 2017).

HEALTH IMPACTS

Good ventilation eliminates not only unpleasant smells but also microorganisms. Air is one of the most common pathways in which microorganisms can infect a wound. Postoperative infections arise when pathogens reach the operation wound during the surgical procedure. The main source of such pathogens is the skin of the staff, each person sheds about 1000 bacteria-carrying particles each minute. Another less common risk, is the risk of spreading an airborne disease due to unsuitable ventilation channels.

A well-functioning ventilation system also has a positive effect on the working environment as it minimizes noise pollution and draft (Arbetsmiljöverket, 2020; Socialstyrelsen, 2006).

TECHNOLOGY FOR VENTILATION

There is a wide range of technologies for ventilation to optimize performance and increase energy-efficiency. Depending on the setting, different factors are important in terms of ventilation. For example, in an operating room it is of outmost importance that ventilation prevents the spreading of air-born infections. In an examination room ventilation is adjusted to create a good indoor climate for patient and staff (Dahlberg, et al. 2016).

Below technologies for ventilation in hospitals and other healthcare facilities are presented in more detail.

LAMINAR AIRFLOW (LAF)

The most common ventilation technology in Swedish operating rooms is laminar air flow or unidirectional air flow, also known as LAF or UDF-technology. This technology is situated above the operating table and pushes the airflow through high-efficiency particulate air filters, or HEPA-filters, above the operating table, creating a unidirectional airflow. The incoming air enters the room through a box in the ceiling, creating an ultra-clean zone over the operating table (Alsved, et al., 2017).

TEMPERATUR CONTROLLED AIRFLOW (TCAF)

TcAF is a rather recently developed ventilation system that is installed in many operating rooms in Sweden. TcAF is a technology that enables control of air movements, as well as the aiflow´s fall speed over the patient and healthcare staff.

The TcAF ventilation system pumps out clean and filtered air which is 1.5°C colder than ambient air into a zone around the operating table. The temperature difference in the room gives rise to a flow directed downwards towards the operating table and from there out towards the outer edges of the room. The technology is energy-efficient, reduces bacteria-carrying particles in the entire operating room, and creates a better working environment for healthcare staff (Alsved, et al., 2017).

EU STANDARD

The EU standard CEN/TS 16244:2018 sets the minimum requirements for ventilation in hospitals. The standard includes:

1. Air quality (e.g. cleanliness levels, temperature, humidity, air quantity)
2. The protection of patients, staff and visitors against harmful agents
3. Reducing the growth of microorganisms (e.g. clean-ability, accessibility, wet surfaces, accumulation of particles)
4. Control of the airflow direction (e.g. tightness of systems and constructions, pressure difference

CEN/TS 16244:2018.

TECHNOLOGY FOR VENTILATION

TURBULENT MIXED AIRFLOW (TMA)

Turbulent Mixed Airflow, also known as TMA-technology, is a traditional type of ventilation. The technique adds an inflow of clean and filtered air, but without the flow having any predetermined direction. TMA is based on a dilution principle, the airflow enters the room through a HEPA filter and dilutes contamination to a lower level, which results in an exponential decay of airborne microbes over time. With these systems, the air often enters through a panel along the top wall and is exited close to the floor in the opposite wall. As a result of the turbulent mixing, the concentration will be uniform in the entire room (Alsved, et al., 2017).

DEMAND CONTROLLED VENTILATION (DCV)

Demand Controlled Ventilation (DCV), is a method used to automatically adjust ventilation in response to changes in conditions. Smart systems can change the indoor ventilation in accordance with the need for heating and cooling, indoor pollutants, and occupancy. Through surveillance the DCV system can optimize ventilation to current conditions and with this also optimize the energy use of hospitals or other healthcare facilities (Lawrence, 2004).

ENERGY RECOVERY IN HOSPITAL KITCHEN VENTILATION

New innovations have enabled energy recovery in ventilation systems in restaurants and larger kitchens. This technique could also be applicable specifically in hospital kitchens in order to save both costs and energy use for the healthcare sector.

The technique functions through a unique exhaust air heat pump, which allows particles from grease and soot to pass through rather than stick to the unit. As a result, there is no need to filter the incoming air and the technique allows for a stable airflow. Thanks to the heat pump, recovered energy can be re-distributed to connected systems. The system requires low maintenance and has a low energy use and can therefore contribute to both cost savings and have a positive impact for the environment (Hansson, 2019).

MAINTENANCE

Maintaining the ventilation system is important in order to optimize the function, remove odors and lower the energy use. Parts of the ventilation systems contains of fragile structures that should be periodically maintained, but not cleaned with regular cleaning agents. One method to maintain the ventilation system in a sustainable way is by using dry ice blasting. The dry ice is used to pulverize and remove dirt, while using neither water nor chemicals. This improves indoor air quality and lower operating costs of the system (Clarin, 2020).

EXAMPLES FROM SWEDEN

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REGION VÄSTERBOTTEN

NORRLAND UNIVERSITY HOSPITAL

At Norrland University Hospital's premises in Region Västerbotten, Demand Controlled Ventilation (DCV) is usually installed in new buildings. These systems are connected to new duct systems supplied by new ventilation units. Both duct systems and units are designed for this purpose.

The DCV system has double units with counter current heat exchangers. A higher degree of visualization (at room level) has been experienced compared to previous ventilation systems. Also, there has been a higher efficiency (up to 90% exhaust efficiency) and higher robustness due to double units as well as fan walls. So far, the experience is positive regarding the indoor climate, and the number of fault reports in regards of poor indoor climate has decreased.

Previous experience has shown a great energy saving potential with DCV systems in office environments. In the healthcare environments, there is currently not enough input yet to be able to give exact figures on the energy savings. However, an increase in comfort cooling has been observed. The maintenance of the ventilation system is something that will be evaluated further.

The duct systems today contain far more components than before. However, there are more opportunities to detect errors. Previous experience from other environments has not revealed a great need for maintenance on DCV systems. The newer duct systems that are installed need different competencies than were needed before. The focus is now more on the overall understanding of indoor climate, energy technology and control – while it was mainly focused on mechanical maintenance when older systems were in place.

In addition, the duct systems today are in greater need of continuous optimization and supervision. On the other hand, the systems are also more flexible and changes that had previously involved construction measures and even longer downtime can today often be handled by changing the adjustment values in the control system. The DCV systems provide good opportunities to be used as tools for various types of operational optimizations and troubleshooting (Region Västerbotten, 2020).

EXAMPLES FROM SWEDEN

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REGION HALLAND

HALMSTAD HOSPITAL

At Halmstad Hospital in Region Halland, the ventilation units are continuously upgraded and replaced every year depending on the need. As the ventilation units become more modern they also are more energy efficient.

Each ventilation unit has a life span of approximately 25 years, but they are regularly upgraded to meet new requirements and criteria for air flow, temperature, particulate matter and purification filters. There are various criteria´s which govern which ventilation components that needs to upgraded or replaced, for example, the temperature in the hospital cannot be warmer than 25 degrees. HEPA-filters need to be in place, as well as ventilation units which circulate the air in the room to avoid a mixture of particles.

The hospital has installed various ventilation techniques in the different sections of the hospital. For example, they have installed DCV, which measures CO_2 in the air and adjusts the ventilation accordingly. This is a way to further save energy use of the ventilation system.

The Halmstad Hospital has measured their total energy use over the time period 2007-2020. During this time span, the hospital´s energy use has decreased by 20%. During this period there has been a number of replacements of ventilation fans to more modern technology. This has contributed to the hospital´s overall reduction of energy use (Region Halland, 2020).

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ABOUT NORDIC KNOW-HOW

Nordic Know-How is a report series created by Nordic Center for Sustainable Healthcare (NCSH), within the project *Platform for Internationalisation: Energy and Climate Smart Healthcare*. The project is financed by the Swedish Energy Agency.

This series consists several reports which provide an overview of good examples and best practices of sustainable healthcare in the Nordics.

Each report has a certain theme relating to a sustainability challenge in the healthcare sector. The purpose of this series is to bring Nordic practices and knowledge to international actors, spreading Nordic expertise in this field to the world.

Nordic Know-How:
#1 Nitrous Oxide Destruction
#2 Geothermal Energy
#3 Lighting
#4 Ventilation

NCSH Nordic Center for Sustainable Healthcare

Swedish Energy Agency