# Possible effects of new Swedish ventilation regulations for residential buildings

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# Possible effects of new Swedish ventilation regulations for residential buildings

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**Abstract.** In March 2023, the Swedish national Board of Housing, Building and Planning (Boverket) published a proposal for new ventilation rates in Sweden. The supply air should by this be calculated based on an equation using the heated floor area as the main input. It is set as optional to use less ventilation flow if this could be sufficient. However, in a questionnaire to Swedish practitioners within the field, this option is said to be seen to be seldomly used. The new suggested regulation will have a high impact on the ventilation air flow in dwellings, with a major impact on smaller dwellings, but also on dwellings with a size of 60 – 80 $m^2$. Using the suggested ventilation air flow, the increase will be more than 100 % in dwellings < 50 $m^2$ and between 60 – 80% in dwellings of 60 – 80 $m^2$. The higher ventilation rates will increase the overall energy demand for buildings, both due to electricity demand for ventilation fans as well as energy to cover heat losses. The increase in energy demand will by this impact on the GWP during operations. A higher ventilation rate also affects the costs within construction and decrease rentable space.

## 1 Introduction

Proper ventilation (air exchange rate) in buildings is a crucial feature in order to ensure a healthy indoor environment. The understanding of the relation between ventilation and health is not new, possible first introduced in 1863 [1].

For more than 40 years, the Swedish building regulations has required a minimum ventilation flow of 0.35 l/$m^2$, s. Equal to an air exchange rate of $0.5^{h-1}$ for a dwelling with a room height of 2.5 m [2]. Furthermore, in Swedish dwellings, it´s allowed to reduce the air exchange rate by roughly 70 % when there are no occupants in the dwelling.

The air exchange rate in a dwelling is usually a trade-off between the overall aim to minimize the energy demand needed for ventilation heat losses, energy use for fans and the need to ensure a healthy indoor environment. A British study from 2013 suggested that, considering both energy and indoor environment, optimal air exchange rates would be $0.4^{h-1}$ in a single family house and $0.7^{h-1}$ in a multi-dwelling building [3].

Focusing specifically on health aspects, a more recent study tried to identify air exchange rates which would protect against health risks in residential buildings [4]. The study concluded that available data within that study could not provide a concrete basis for determining specific air exchange rates for residential buildings in order to protect against health risks.

I.e., determining the best air exchange rate in dwellings is not an easy task.

The current minimum ventilation requirements in Denmark [5], Finland [6], Norway [7] and Sweden [2] is summarised in Table 1.

**Table 1.** Summary of ventilation requirements for dwellings today, when occupied

| Country | Ventilation rquirement (l/s, $m^2$) |
|---|---|
| Denmark | 0.30 |
| Finland | 0.35$^{\infty}$ |
| Norway | 0.33 |
| Sweden | 0.35 |

$^{\infty}$Ventilation rate is not allowed to be below 18 l/s, dwelling

## 2 Proposed new Swedish ventilation requirements

In March 2023, the Swedish National Board of Housing, Building and Planning (Boverket) published their new suggestion for ventilation requirements for dwellings, translated from Swedish by the authors [8]:

*"Dwellings must be designed so that they can have a supply air flow according to Equation 1, where A indicates the living area of the dwelling expressed in meter square.*

$$q_{supply\ air} \geqslant 4 * A^{0.55}\ [l/s] \qquad (1)$$

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*The requirement does not need to be met if it can be shown that a lower supply air flow is sufficient to meet requirements with regard to intended use, existing pollution and technical solution."*

As the existing requirement of ventilation flow (0.35 l/s, m$^2$) is a minimum requirement and does not give any recommendations related to different types of rooms in dwellings; it is rather common that HVAC consultants design ventilation systems in residential buildings based on recommendations given by the HVAC sector [9], previously also given in Swedish building regulations [10] as presented in Table 2.

**Table 2.** Summary of most common ventilation recommendations in Sweden

| Room | Minimum exhaust air (l/s) |
|---|---|
| Kitchen | 10 |
| Bathroom with openable window | 10 |
| Bathroom without openable window | 15 |
| Toilett | 10 |

Also, wort mentioning is the European norm EN 16798-1 [11] which recommends total ventilation air flow of 0.23-0.49 l/s, m$^2$, including infiltration, for residential buildings.

The purpose of this paper is to study the consequences of the new proposed ventilation requirements for residential buildings in multi-dwelling buildings in Sweden, initially suggested to come into force in July 2024. The new requirement may have a great impact as the annual need for new dwellings in Sweden are almost 70 000 dwellings per year up until the year of 2030 [12].

Recently, the proposed new regulations have been sent out for consultation, and there has been a great deal of interest from the consultation bodies. By this, Boverket believes that more time is needed to review the comments. The new timetable propose entry into force of the new regulations on 1 January 2025.

# 3 Method

The study of the new ventilation requirement is carried out in four steps:

1. Quantification of ventilation requirements
2. Interpretation of new ventilation requirement
3. Energy and GWP effects
4. Monetary effects of new ventilation requirement

## 3.1 Quantification

The Swedish ventilation requirement today, and the proposed ventilation requirement are used as input when calculating the ventilation demand for a multi-dwelling building of 1 000 m$^2$, with eight (8) two-room-apartments and six (6) three-room-apartments. Where the size of the appartements are the most common in Sweden today [13];

- Two-room-apartment, 59 m$^2$
- Three-room-apartment, 78 m$^2$

Both apartments are assumed to have one kitchen and one bathroom without an openable window.

## 3.2 Interpretation

A questionnaire compiled with questions as below was distributed to HVAC consultants in Sweden and energy- and operating experts working with Public Housing Sweden.

- Q1: Which are your main work tasks (possible to choose more than one)? Ventilation design, Piping design, Electrical design, Control design, Energy design, Project management, Controller, Property management, contractor, Other
- Q2: Years of experience within the field? <1 year, 1-5 years, 5-10 years, >10 years
- Q3: How do **you** interpret the new ventilation requirement?
- Q4: How do **you expect HVAC consultants** will interpret the new ventilation requirement?
- Q5: How do **you expect municipal supervisory authority** will interpret the new ventilation requirement?
- Q6: Other comments or aspects you would like to share with us?

For questions 3-5 the alternatives for answers were the same:

- The new requirement will be an absolute minimum
- The new requirement will, in principal, be an absolute minimum, lower ventilation will seldom be used
- The new requirement will be a general approach for minimum ventilation, lower ventilation will sometimes be used
- The new requirement will be a general approach for minimum ventilation, lower ventilation will often be used
- The new requirement will not be relevant, lower ventilation will almost always be used
- I don´t know

## 3.3 Energy and GWP

The increased energy use due to higher ventilation rates is calculated assuming that the building has mechanical ventilation with heat recovery (MVHR) with a specific fan power (SFP) of 1.6 kW/m$^3$s and a heat exchange efficiency of 80 %. Energy for fans and ventilation losses are calculated according to SS-EN ISO 13790 [14] for Stockholm (latitude, longitude: 59.33, 18.06)

The calculated global warming potential (GWP) related to energy use may vary greatly depending on boundary conditions and calculation methods [15, 16].

In this study $GWP_{heating}$ is set to 0.100 kg $CO_{2\ eq.}$/kWh and $GWP_{electricity}$ is set to 0.150 kg $CO_{2\ eq.}$/kWh.

### 3.4 Monetary effects

Monetary effects of the new suggested ventilation rates are quantified by calculating costs for larger ventilation units and ducts combined with loss of saleable area due to increased size of shafts.

The increased size of shafts is based on choosing ducts that will result in the same air speed, comparing existing and new ventilation requirements.

Costs for ducts and ventilation units are calculated using Wikells Sektionsdata [17]. Cost for loss of saleable area is based on a price of 4 300 €/m$^2$ [18]. Costs for energy is based on average costs according to a Swedish cost study from 2023, called Nils Holgersson [19], where average costs for district heating and electricity is 0.10 €/kWh and 0.30 €/kWh, respectively.

## 4 Results and Discussions

### 4.1 Quantification

A comparison of ventilation requirement today and proposed requirement in relation to size of dwelling is presented in Figure 1. For dwellings smaller than 50 m$^2$, the ventilation flow is increased by >100 % using the suggested value. For dwellings 50–90 m$^2$, the ventilation flow is increased by 50–100 %. For dwellings larger than 200 m2, there is a small difference between existing requirement and proposed requirement. However, dwellings >200 m$^2$ in multi-dwelling buildings are very rare. As mentioned in section 3.1, the most common appartements are 60–80 m$^2$, where the new requirement could result in increased ventilation flow by roughly 60–80 %.

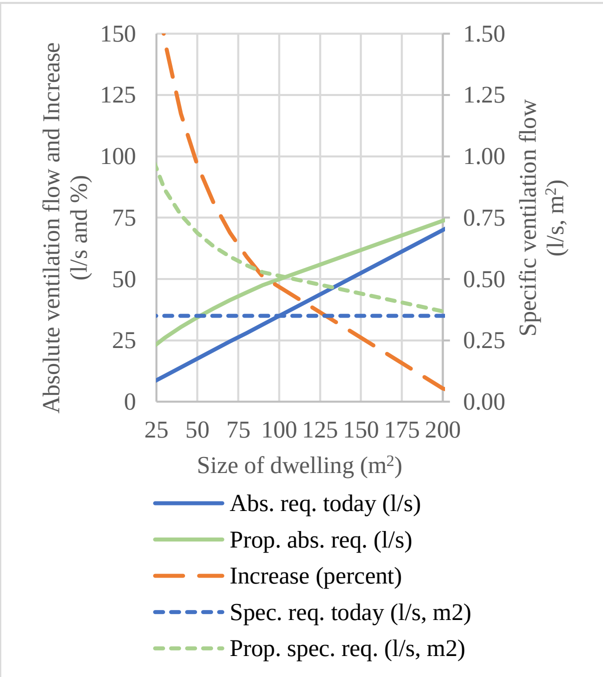


**Fig. 1.** Comparison of ventilation requirement today and proposed ventilation requirement

The proposed ventilation requirement is higher than the highest recommended value in EN 16978-1 (0.49 l/s, m$^2$) for dwellings <100 m$^2$.

Calculated values for the multi-dwelling building are presented in Figure 2. As can be seen, the calculated value for ventilation, based on existing recommendations presented in Table 2, is higher compared to legal requirement today. The calculated value for ventilation would have been even higher if the calculations would have been based on assumption of more bathrooms and/or toilets in the appartements. Comparing the ventilation legal requirement today and the proposed requirement, the ventilation is increased by 61 %.

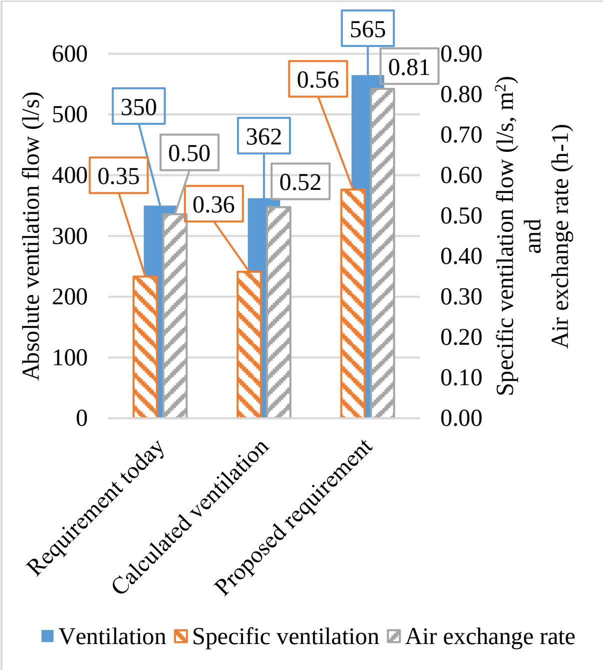


**Fig. 2.** Comparison of ventilation requirement today, calculated ventilation and proposed ventilation requirement for a multi-dwelling building

### 4.2 Interpretation of ventilation requirement

A total of 50 answers were gathered via the questionnaire. The general background of the respondents is presented in Figure 3 and Figure 4. The most common work tasks within the respondent group are ventilation- or piping design, energy or property management. Overall, 70 % of the respondents has more than 10 years of work life experience. I.e., the respondents form a group which have good knowledge within the field, are able to make qualified assessments and could be seen as good representatives of the Swedish interpretation.

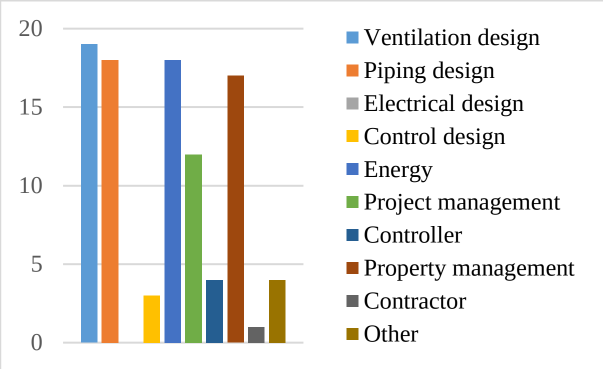


**Fig. 3.** Main work tasks carried out by the respondents

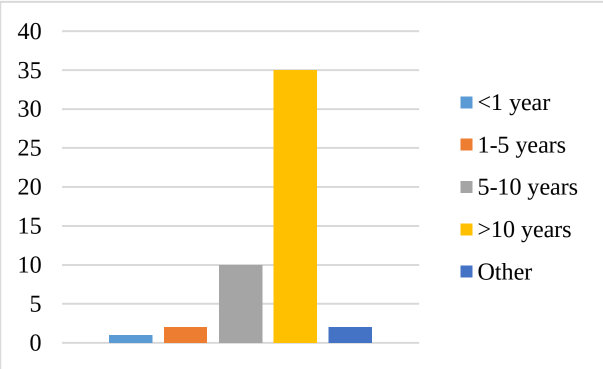


**Fig. 4.** Years of work experience of the respondents

The focus of the questionnaire, how the new ventilation requirement may be interpreted, is presented in Figure 5. Regardless of whether the respondents take the perspective of their own interpretation (Q3), assumed HVAC consultant interpretation (Q4) or municipal supervisory authority interpretation (Q5), the most common answer is that the new requirement will be a principal requirement where lower ventilation seldom will be used (40–46%). The second most common answer based on their own interpretation and assumed HVAC consultant interpretation is that the new requirement will be a general approach for minimum ventilation, lower ventilation will sometimes be used (24–28%). When the respondents answer how they believe municipal supervisory authority will interpret the new ventilation requirement, the second most common answer is that the new requirement will be an absolute minimum (32%). I.e., in general, the new requirement is expected to be a principal requirement, but municipal supervisory authorities are expected to may, in many cases, treat the new requirement as an absolute minimum.

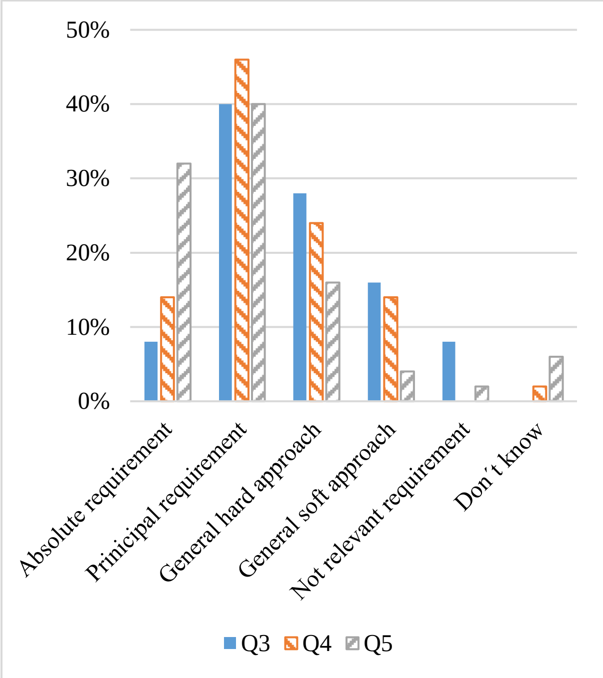


**Fig. 5.** Relative distribution of questions 3-5; interpretation of the new ventilation requirement

### 4.3 Energy and GWP

Results from energy calculations for the previously described multi-dwelling building are presented in Figure 6.

As calculations according to SS-EN ISO 13790 does not consider dynamic effects such as freezing in heat exchanger, the increased energy demand for fans and ventilation losses and the thereby increase of GWP is 61 %, same as the increased ventilation flow.

Assuming, based on the Swedish need for dwellings and interpretation of the new requirement, that this increase would take place in 35 000 dwellings per year, the effect of the new requirement would be an annual increase of electricity demand by 7.5 GWh/year (electricity for fans), increase of heating demand by 14.6 GWh/year (ventilation losses) and increase of GWP by 2.6 tons of $CO_{2\,eq.}$/year.

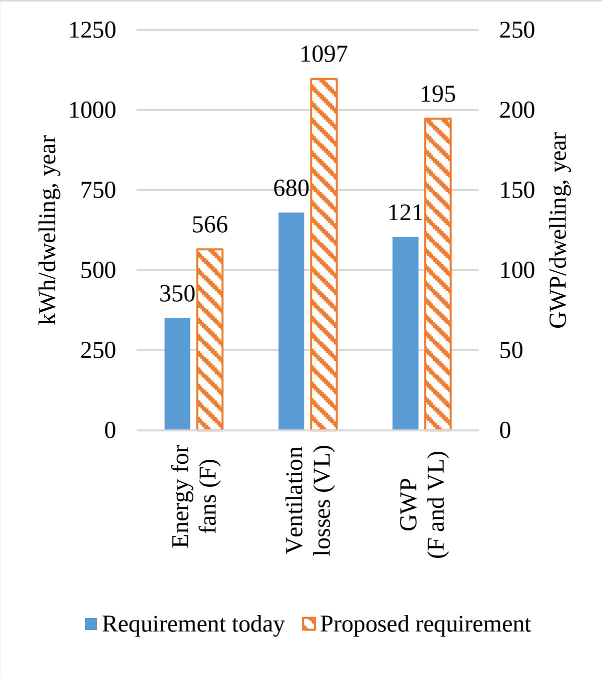


**Fig. 6.** Results from energy and GWP calculations

### 4.4 Monetary effects

Based on the increased energy use, Figure 6, the energy costs related to fans and ventilation losses increase by 62 %, from 2 422 €/year (173 €/dwelling, year) to 3913 €/year (280 €/dwelling, year).

The costs for circular ducts in relation to cross-sectional area are presented in Figure 7. As can be seen there is a strong linear relationship between the cross-sectional area and price. If the cross-sectional area increases by 1 $dm^2$, the cost of the duct will increase by almost 4 €/m. The strong relationship is most likely due to there being a strong correlation between cross-sectional area and quantity of steel needed.

The costs for ventilation units in relation to recommended ventilation flow is presented in Figure 8. Here, the relation between ventilation flow and price is not as strong as for the ducts. Most likely due to that different ventilation units have different product standards. E.g., what kind of control functions are included, size of preheating batteries, etc. However, based on the linear interpolation, one may expect an increased price of a ventilation unit of roughly 1 250 € if the ventilation flow increases by 100 l/s.

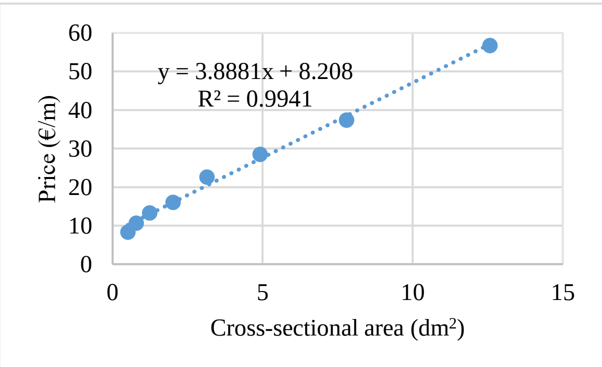


**Fig. 7.** Circular ducts price in relation to cross-sectional area

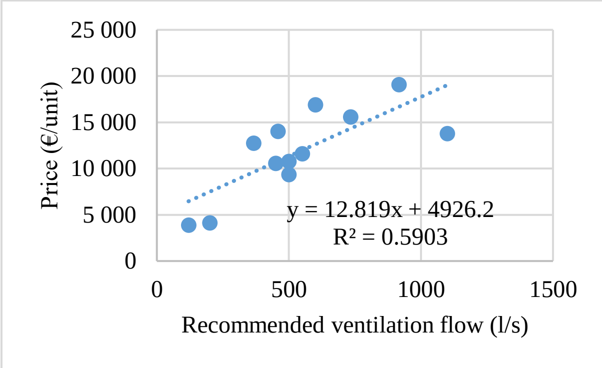


**Fig. 8.** Ventilation unit price in relation to recommended ventilation flow

Material costs are expected to increase as presented in Figure 7 and Figure 8. Costs for installation work are calculated not to increase. Based on this, cost for the ventilation system for the multi-dwelling building is calculated to be 51 194 € for the multi-dwelling building (3 657 €/dwelling) based on existing ventilation requirement and 64 633 € (4 617 €/dwelling) based on the proposed requirement. I.e., a cost increase of 26 %. Furthermore, loss of saleable area is assumed to be 0.2 $m^2$/dwelling. I.e., loss of earnings due to saleable area, due to space needed for larger ventilation shafts, decrease by 860 €/dwelling or 12 040 € for the multi-dwelling building.

It should be noted that the loss of earnings (12 040 €) is almost as high as the increased costs for the ventilation (13 440 €).

## 5 Conclusions

The suggested requirement on new ventilation rates in Sweden as presented by the National Board of Housing (Boverket) will have a high impact on future buildings, both regarding energy demand, energy costs, GWP as well as increased costs within construction.

Due to the structure of the equation used as a base for the requirement, the highest difference between current demands and future ventilation rates will be in dwellings smaller than 50 $m^2$, with an increase of the ventilation flow of >100%. The regulations admit using a lower ventilation flow if this can be proved to be sufficient for the application. However, asking practitioners within the field on how they interpret on this possibility, it is considered seldom to be used.

For dwellings with a heated floor area of 60 – 80 $m^2$, the increase of ventilation flow is roughly 60 – 80%. Since this is the most common size of apartments in Sweden, the suggested new regulation will have a high impact on future buildings. With an assumption of 35 000 new apartments built yearly, within the size of 60 – 80 $m^2$, the new regulations will cause an increase of electricity demand of 7,5 GWh/year (electricity for fans) and increase of demand for heating by 14.6 GWh/year (ventilation losses).

The higher ventilation rates will also increase the need of space due to larger ducts and shafts. This will cause an increase in ventilation costs of 26%. The larger shafts will also result in loss of earnings, almost to the same extent.

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