# IEQ-compass

## Tool able to determine the potential indoor environmental quality in single-family houses

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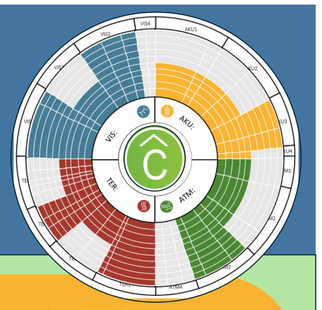



## What is indoor environmental quality?

Indoor Environmental Quality (IEQ) describes the overall conditions inside a building that affect the health, comfort, and well-being of its occupants. It is shaped by thermal comfort, ensuring appropriate temperature; visual comfort, including proper lighting and access to natural daylight; acoustic comfort, which involves managing noise and sound levels; and atmospheric quality, referring to clean air and effective ventilation. Together, these factors can create a healthy and pleasant indoor environment if managed appropriately. If IEQ is neglected it can heavily affect the occupant's concentration and efficiency and in long term the overall wellbeing and health.

## What is IEQ-compass?

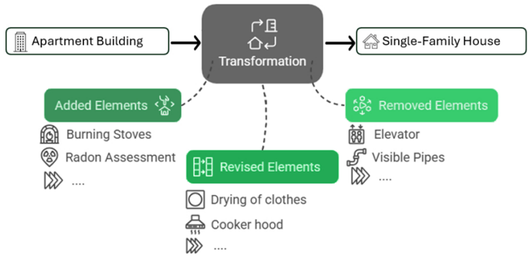
| IndeklimaKvalitet | Score (andel af maksimalt opnåelig score) |
|---|---|
| A | 85% ≤ score ≤ 100% |
| B | 75% ≤ score < 85% |
| C | 65% ≤ score < 75% |
| D | 55% ≤ score < 65% |
| E | 45% ≤ score < 55% |
| F | 35% ≤ score < 45% |
| G | 0% ≤ score < 35% |

With 42% of the building stock being single-family houses, and people spending 90% of the time indoors, there should be more focus directed IEQ.

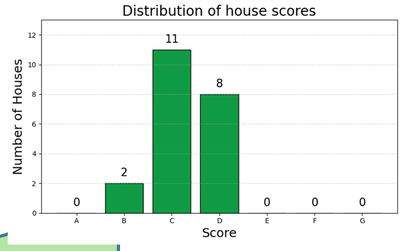
To ensure a good IEQ in buildings there must be an easy way to quantify it and compare building to one another. IEQ-compass for apartments is an assessment tool developed here at AAU that solely focuses on IEQ. The results are presented in the same manner as an energy label – from A to G – and is therefore easy comprehensible.

## Adaptation of IEQ-compass

To develop IEQ-compass to be eligible for single-family houses, an investigation of input parameters must be performed. This alteration requires a revision of current inputs, a removal of current inputs as well as an addition of new inputs relevant for single-family houses. Key elements like radon, air pollution, fire stoves, bypass in the air handling units have been implemented among many other parameters.

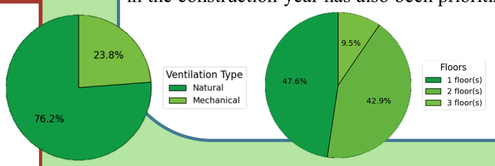


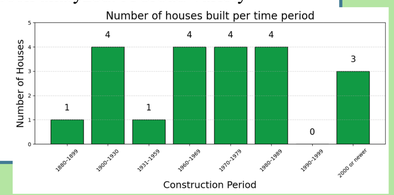

## Case study application




Having adapted the tool a case study testing single-family houses was conducted. The study's purpose was to find inadequate inputs and see how the new inputs were managing. A number of 21 houses was examined where approx. 25% were installed with mechanical ventilation and the remaining with natural ventilation. The results from the case study showed that most houses reached a score of C where the remaining houses scored B and D. This leaves a big percentage of the scoring scheme not being used.

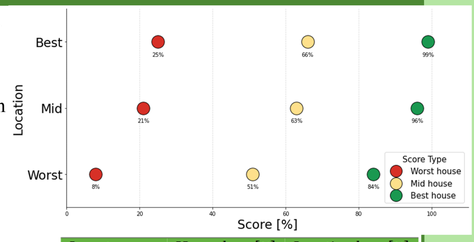
To ensure broad variation in buildings characteristics, a diverse set of houses have been selected for investigation to increase the credibility of the study, Houses with both mechanical and natural ventilation have been analyzed. A broad variety in the construction year has also been prioritized.




## Boundary case analysis

This analysis was set out to establish if IEQ-compass was able to utilize the entire scoring scheme and achieve scores in both extremes. There has been created nine different houses ranging from the worst to middle to best case for both location and house quality.

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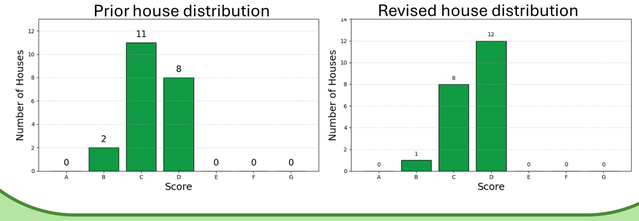
| IEQ | Score |
|---|---|
| A | 90% ≤ score ≤ 100% |
| B | 80% ≤ score < 90% |
| C | 70% ≤ score < 80% |
| D | 55% ≤ score < 70% |
| E | 40% ≤ score < 55% |
| F | 20% ≤ score < 40% |
| G | 0% ≤ score < 20% |

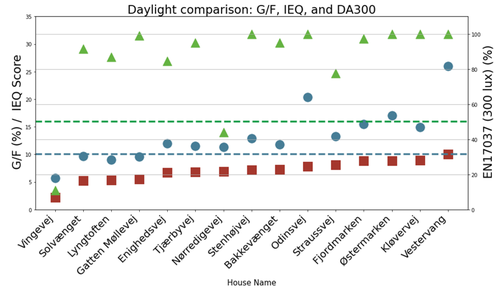
| Leap type | House leap [%] | Location leap [%] |
|---|---|---|
| Worst to mid | 41-43 | 12-13 |
| Mid to best | 33 | 3-4 |
| Worst to best | 74-76 | 15-17 |

It is desired that the location itself can regulate the score by at least one grade, no matter the house quality. In the current scoring scheme that is not possible in the bottom of the scale. Because of this, and the narrow distribution of scores from the case study results, a revised scoring scheme has been suggested.




## Validation of calculation accuracy in IEQ-compass

Some calculations in IEQ-compass has been simplified to reduce the time and computational power needed to use the tool. Some of these has been examined to test whether they are representative.



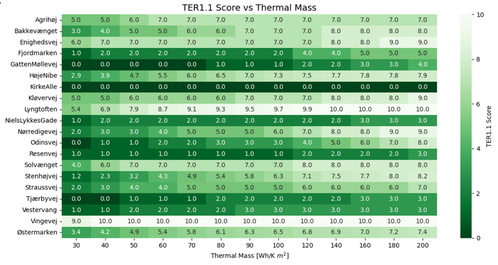

**The daylight** calculation was examined by comparing the glass-to-floor ratio method in IEQ-compass with a climate-based daylight modelling program utilizing the 300-lux method from DS17037.

**Direct sunlight** is determined from a single day as prescribed in Danish Standards. This methodology has been challenged, and calculations of direct sunlight over a period have been conducted.

*Table 9.3.* Comparison between period and singular day.

| Day/ period | 1.February | Jan-Mar | Sep-Dec |
|---|---|---|---|
| House | Hours of sunlight | | |
| Gatten Møllevej | 1.5 | 2.0 | 1.9 |
| Høje Nibe | 2.0 | 3.3 | 3.2 |
| Kirke Alle | 2.0 | 3.4 | 3.3 |
| Kløvervej | 1.0 | 1.9 | 1.9 |
| Lyngtoften | 1.5 | 2.4 | 2.4 |
| Strausvej | 1.8 | 2.8 | 2.6 |
| Tjærbyvej | 1.6 | 2.7 | 2.7 |
| Mean | 1.6 | 2.7 | 2.6 |

**Thermal mass** is interpreted in different ways. Energy consultancy companies estimate the thermal mass by the back wall alone. The impact of the thermal mass on the thermal scoring was investigated, and the results show an increase in scores, when increasing the thermal mass of the house.




## Conclusion

This project adapted, corrected, and optimized IEQ-compass for evaluating indoor environmental quality in single-family houses. The modifications ensured IEQ-compass's suitability to the unique characteristics of single-family houses.

Through a comprehensive case study of single-family houses, models were tested to ensure good usability. The case study also showed that with the current scoring scheme, the typical single-family houses will get a poor differentiation among them and not use the full spectrum of the scale.