

CLIMATIC DESIGN CONSULT
ADVIESBUREAU VOOR BOUWFYSICA

Energy Performance Coefficient of office buildings related to the measured energy consumption

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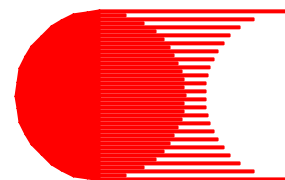
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SUMMARY

The Netherlands Ministry of Spatial Planning, Housing and the Environment (VROM) and the Netherlands Agency for Energy and the Environment (NOVEM) have initiated research into the effectiveness of the energy performance regulations for office buildings. To legitimate the Energy Performance Regulations it needs to be proved that a lower EPC leads to a lower actual energy consumption. This report deals with the relation between the calculated Energy Performance Coefficient (EPC) and the measured energy consumption.

Sample of buildings

By means of multiple regression analysis on a sample of recently built office buildings the relation between the EPC and the energy consumption is investigated. The minimum sample size that was aimed for was 100 buildings. For 126 buildings¹ the EPC-calculations were available, of 94 buildings the energy consumption data could be acquired and finally 73 buildings have been used for the analysis.

Relation between EPC and actual energy consumption

Figure 1 shows the measured primary energy consumption (office equipment like copiers and computers included) against the calculated EPC.

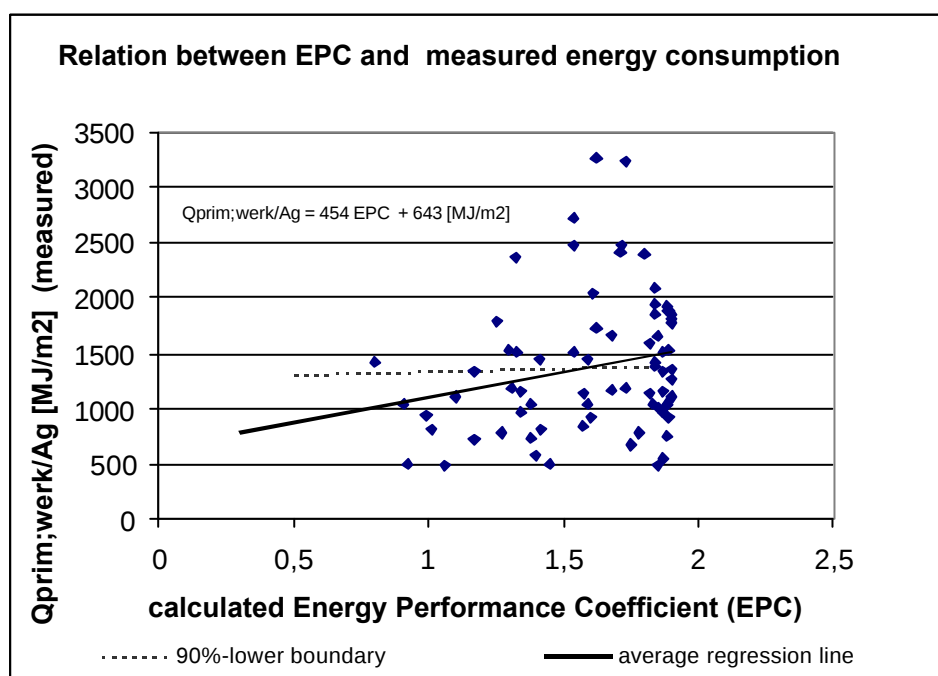
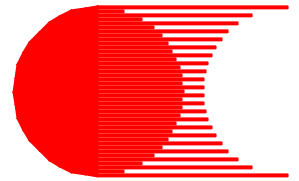


Figure 1 Relation between EPC and energy consumption

¹ Not all EP-calculations were produced for the building permit application. A number were EP-calculations of existing buildings with a number of assumptions and default input values. These buildings are omitted in the final sample of analysed buildings.



With a single regression analysis the following relation between EPC and energy consumption can be derived:

$$Q_{\text{prim;werk}}/A_g = 454 * EPC + 643 \text{ [MJ/m}^2\text{]}$$

The regression coefficient for EPC is 454. The p-value (indicating the statistical significance) of this regression coefficient is 0,063. The lower boundary of the single sided 90% confidence interval for the regression coefficient is 53.

A multiple regression analysis with the regressors EPC, envelope area to floor area ratio and percentage of floor area being cooled, gives the best statistical significance. The p-value for the regression coefficient for EPC is 0.029 in this case, with a 90% lower boundary of 135.

Relation between calculated energy consumption according to NEN 2916 and measured energy consumption

The EPC includes some policy based corrections, like corrections for envelope area, corrections for application of comfort cooling, corrections for prescribed ventilation rate. Figure 2 shows the calculated energy consumption according to NEN 2916 against the measured energy consumption.

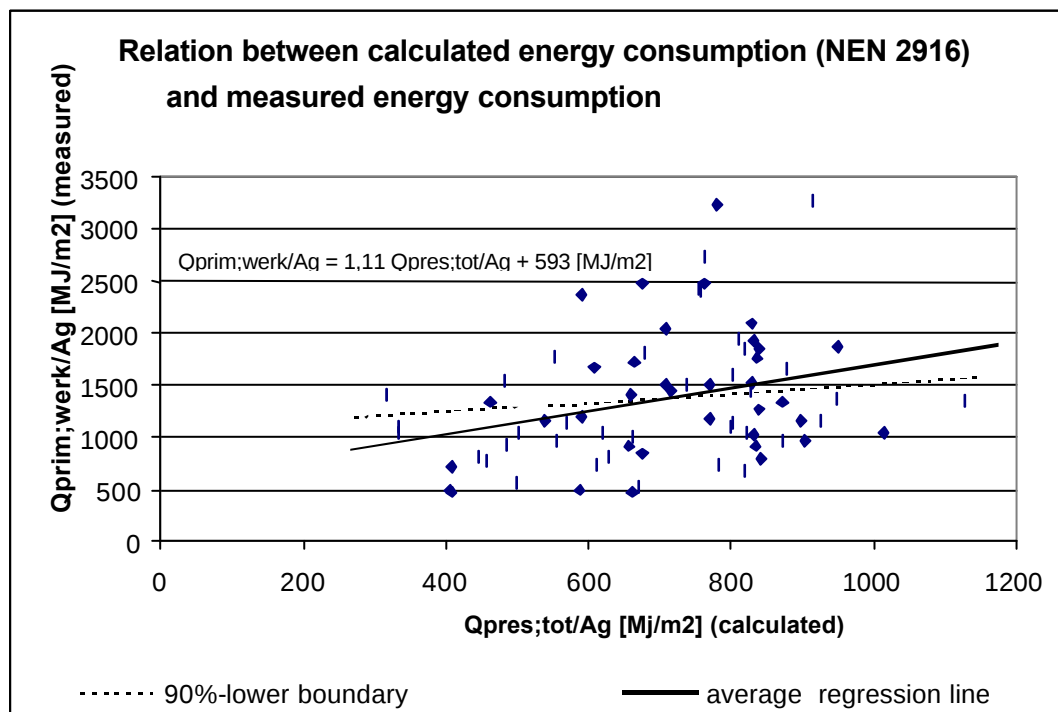
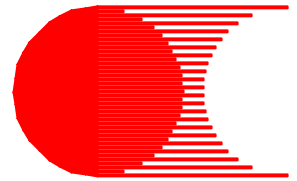


Figure 2 Relation between calculated energy consumption and measured energy consumption



A single regression analysis gives the following relation between the calculated characteristic energy consumption according tot NEN 2916 and the measured energy consumption:

$$Q_{\text{prim;werk}}/A_g = 1,11 Q_{\text{pres;tot}}/A_g + 593 \quad [\text{MJ/m}^2]$$

The p-value of the regression coefficient for $Q_{\text{pres;tot}}/A_g$ is 0,008, the 90% lower boundary of the regression coefficient is 0.43.

REMARK: The figure “593” can be seen as the offset caused by energy consumption not incorporated in NEN 2916 like computers, copiers, etc.

A multiple regression analysis with $Q_{\text{pres;tot}}/A_g$ and the envelope area to floor area ratio gives the best statistical significance. The p-value of the regression coefficient for $Q_{\text{pres;tot}}/A_g$ is in this case 0.0003, with a 90% lower boundary for the regression coefficient of 0.84.

Conclusions

The analyses show a statistical significant relation between the EPC and the measured energy consumption. On the average a lower EPC leads to a lower actual energy consumption, though individual cases are widely scattered.

A part of the scattering is caused by the so called “policy factor”. This factor is introduced in the Dutch regulations to compensate relatively small buildings and buildings with cooling. This “policy factor” can cause buildings with an equal calculated energy consumption to have significant deviating EPC values.

The calculated energy consumption according to NEN 2916 gives an apparently better prediction of the actual energy consumption.

The effectiveness of the Energy Performance Regulations can possibly be improved by reviewing the correction factors for cooling, envelope area and ventilation.