Cost and gain assessment tool for high performance windows

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Synopsis

Presentation of a Dutch and a Finnish cost and gain assessment tool for high performance windows.

Abstract

The impact of the application of high performance windows in buildings can be assessed with the aid of a cost and gain assessment tool regarding both energy performance, thermal comfort and cost. A blueprint for such a tool was developed and elaborated for both Finnish and Dutch buildings. This tool has been developed within the European SAVE programme; project: High performance windows: assessment of energy and cost efficiency and market conditions.

1. Introduction

The application of high performance windows has several consequences for the performance of a building regarding energy consumption, comfort and costs:

- decrease of heat losses through the window and therefore smaller heat demand
- increased daylight and thus diminishing of the energy use by artificial light
- improved thermal comfort because of higher temperature of the window surface
- reduction of the necessity of heating elements near the window
- increase of the useful floor area, because of decrease of the uncomfortable zone near the window
- saving in energy costs
- a more simple heating system

To help designers in making relevant decisions with respect to the applicability of high performance windows in buildings, a blueprint of a cost and gain assessment tool was developed within the European SAVE-programme (Cruchten 1997). The blueprint produces a design tool structure that can be elaborated in different countries according to the national situation. A Dutch and a Finnish elaboration are described here.

2. A tool for Dutch office buildings

The performances of an office building with respect to energy and comfort depend on the interactions between a range of parameters, including the properties of the window. Figure 2-1 shows the diagram by which the relevant relations between input parameters and output performances can be traced. Figures 2-2, 2-3, 2-4 and 2-5 show the four diagrams by which the energy performance and thermal comfort as a result of high performance glazing can be assessed (Cruchten 1997). At the moment the accessibility of the tool is made user-friendly for the target audiences like architects, designers and real estate managers.

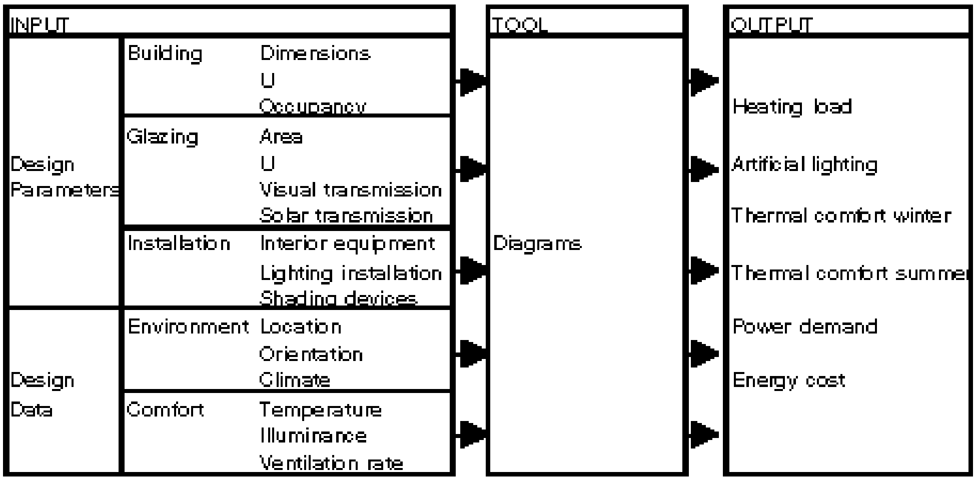

Figure 2-1. Diagram concerning the relations between input and output of the diagrams.

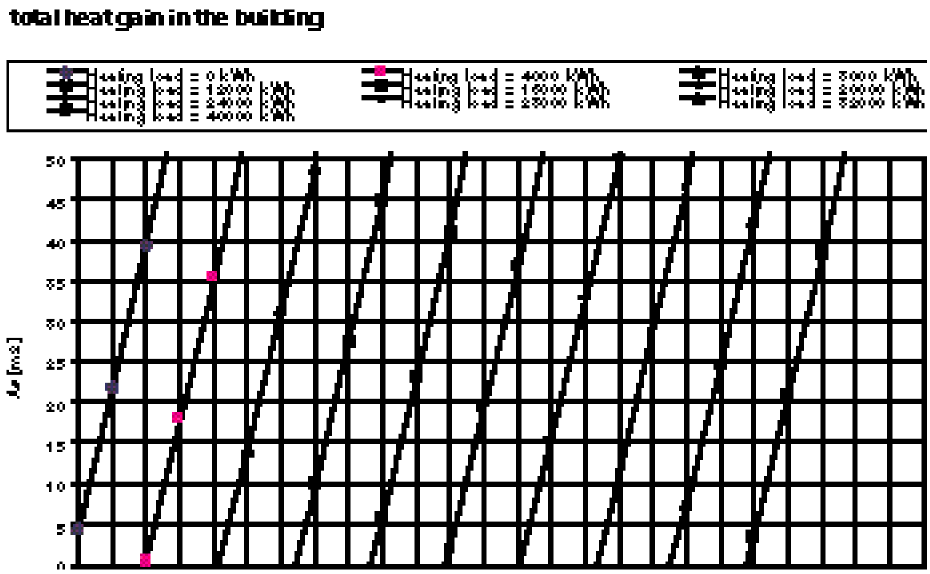

Figure 2-2. The relation between BLC, As and the heating load of a Dutch office building

$$BLC = \sum(A * U) + 0{,}34 * D_v$$

$$A_s = \sum(c * A * G) + b * I$$

Where A = surface area, U = theral transmission, Dv = air flow due to ventilation and infiltration, c = constant depending on orientation, G = solar gain factor, b = constant for conversion from internal gain to south window area, I = internal gain

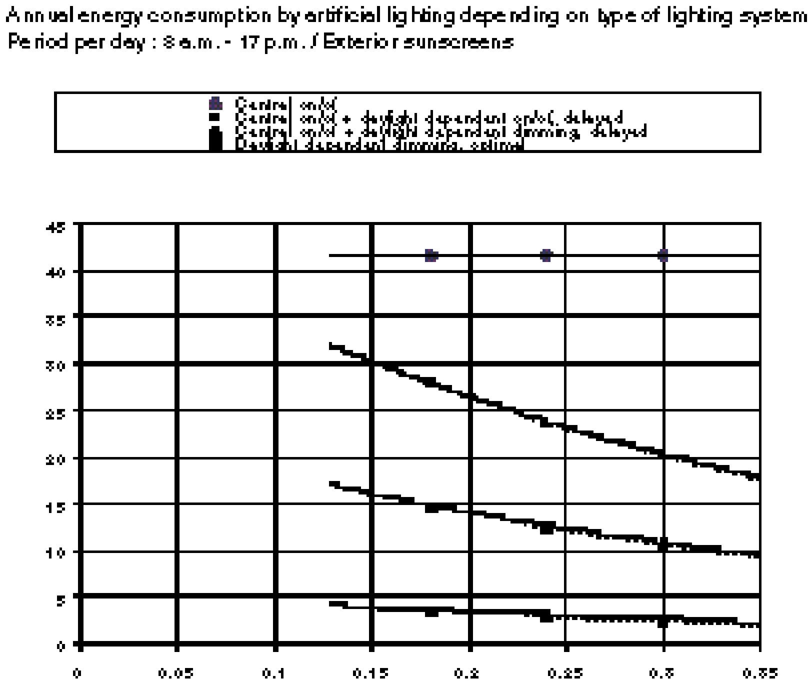

Figure 2-3. The averaged energy consumption of the artificial lighting per square meter floor area (Ial) in relation to the ratio of glazing in the facade (Fg) and the visual transmission of the glazing (() for a Dutch office building (for an office room as a whole and for all orientations).

3. A tool for Finnish buildings

The tool for Finnish buildings is designed to be used on a windows based computing environment. This enables the use of clear interfaces between the user and complicated simulation routines. The tool concentrates on the energy effects, the energy cost effects and the system dimensioning effects of a window selection. The energy effects are predicted as a comparison to a typical window used in Finnish buildings. A window of this kind has an overall *U*-value of 1.9 - 2.1 W/m^2K.

The cost and gain assessment routine is based on a window library and pre-calculated model buildings (office building, apartment block and a detached house). The procedure is based on known, commercially available window products. The main emphasis of the development work has been on this simple procedure to allow a possibility for window trade-offs for ordinary home builders as well.

The tool can be further developed, and the window can then be modelled as a simple selection. The tool will have a link to another calculation program giving the thermal properties of the model window. The windows in the building can be selected facade by facade and varying the window and glazing types in different orientations to be able to optimise the properties of the windows. Also the building can be modelled up to a certain level, which e.g. in Finland will follow the energy calculation method in the National Building Code. The tool is then linked to an energy calculation worksheet program. This procedure is still under development. An overall procedure of the two paths is given in figure 3-1.

The basic research work for the data needed for the tools has been carried out in the Finnish energy research programme Raket (Energy use in Buildings). As an example of this research, the effect of window solar transmittance on the heating and cooling power is shown in figure 3-2 (Virtanen and Heimonen 1996).

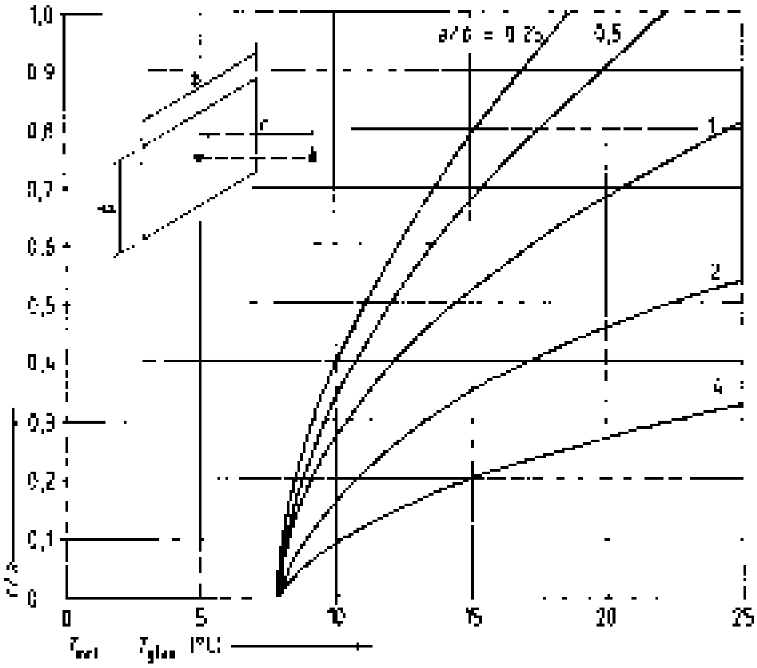

Figure 2-4. The relation between the minimum distance c from the centre of a cold surface (window) with width a and height b at which thermal comfort is just met as a function of the difference between the mean radiant temperature (Tmrt) and the temperature of the cold surface (Tglass) (McIntyre 1980).

$$T_{mrt} - T_{glass} = (1 - F_{glass} * F_f) * 013 * U_{glass} * (T_i - T_e)$$

Where Fglass = ratio of glazing in the facade, Ff = part of the envelope of the room that is taken by the facade, Uglass = thermal transmission of the glazing, Ti = interior air temperature, Te = exterior air temperature.

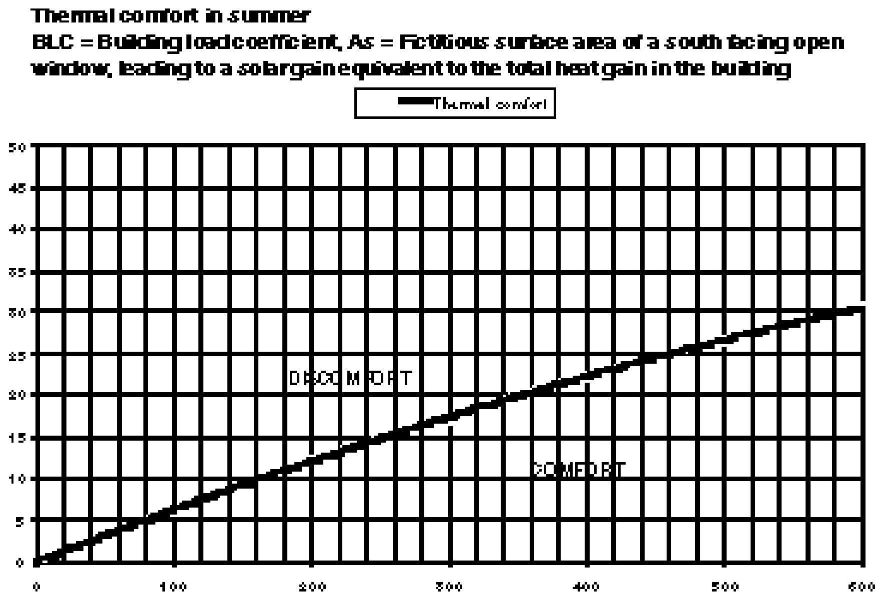

Figure 2-5. The relation between BLC, As and thermal comfort during summer.

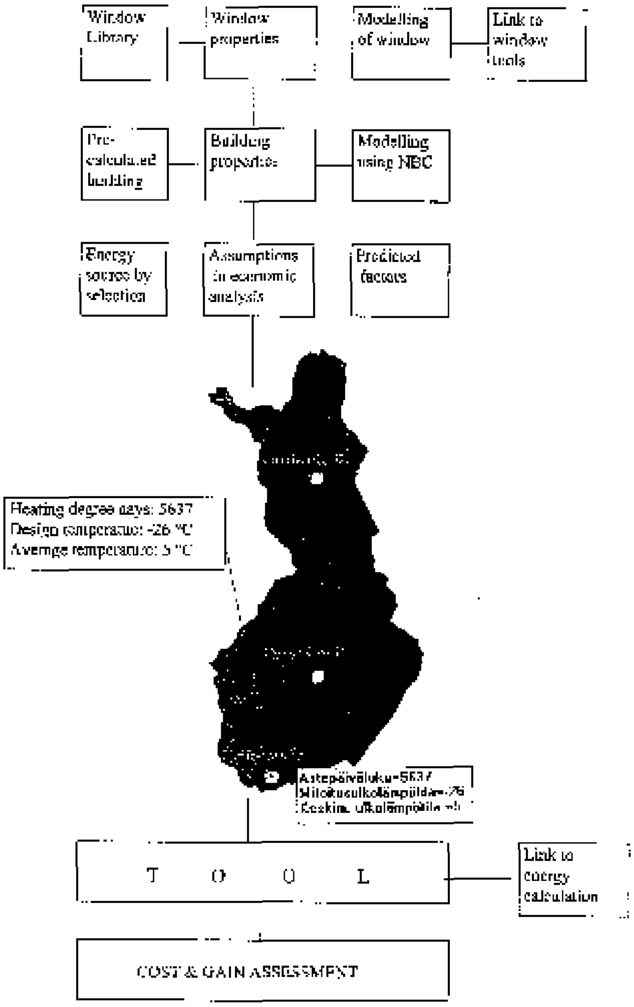

Figure 3-1. Flow chart for a simple cost and gain assessment tool

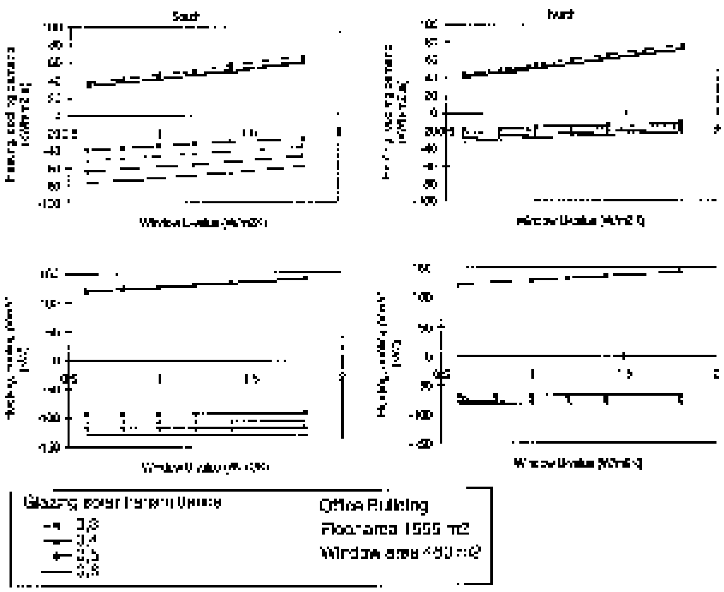

Figure 3-2. The effect of solar transmittance of window glazing on the heating and cooling power need of office building.

References

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McIntyre, D.A. 1980. *Indoor climate.*

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