

Dutch Policy to Promote Energy Efficient Lighting in Non-residential Buildings

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ABSTRACT

New energy performance requirements laid down in Dutch building legislation took effect in December 1995. Compliance with these requirements is necessary to get a building permit. In the past, only requirements for thermal insulation of the building envelope were applicable. Now, requirements have also been imposed on the energy efficiency of hvac systems and lighting. The energy efficiency coefficient (EPC) is a performance standard that expresses the overall energy efficiency of a building as a whole. Lighting systems have a substantial impact on the EPC. The new regulations give designers leeway to combine measures to achieve the required EPC.

GENERAL BACKGROUND

Until December 1995, the energy sections of the Building Decree contained provisions for the minimum heat resistance of the building envelope, the glazing and the air density. The Building Decree imposed no requirements on systems for climate control, lighting and transport. On the one hand, this decision has the advantage of simple implementation and control, whereas on the other, this limited approach provides no stimulation to optimise the energy management of a building with all its installations as a whole. Furthermore, the limits for building more economically in terms of energy consumption are quickly attained if legislation restricts itself to only a few aspects of a building.

This is why the Dutch government preferred to impose performance requirements on the energy efficiency of buildings as a whole, including the installations these buildings comprise. This not only includes climate control,

ventilation and the hot tap water supply, but also the lighting systems. A new method, the energy performance standard, has been developed to determine the energy efficiency of a building. This method can be used to express the energy efficiency of a building in a single figure; the energy performance coefficient (EPC). The Building Decree lays down threshold values for the maximum permissible EPC. The introduction of this new standard means that the various aspects of a building are no longer assessed individually when applying for a building permit. This gives architects and consultants ample leeway when designing a new building. They are free to opt for design solutions, provided the overall design meets the energy performance requirements.

The energy performance requirement as of December 1995 has been set in such a way that energy consumption has been reduced by 10 to 20% compared to the previous requirements. The government intends to make these requirements gradually more stringent. The requirements will be tightened by approximately 15% in 1998.

DETERMINATION METHOD

The Dutch standard defines energy performance as the measure of the energetic properties of a building. In other words, it indicates how energy-efficient a building is. To determine the energy performance, the characteristic energy consumption and the permissible characteristic energy consumption of a building are calculated. The EPC is the quotient of the characteristic and permissible characteristic energy consumption. The required energy performance depends on the building's function (office building, health care building, building for the hotel and catering industry,

sports building, shop building, etc.). The requirements for each building are determined by means of cost-effect studies based on a package of measures that is more or less cost-neutral in relation to the operating costs. This establishes the required EPC at such a level that the measures imposed by the legislation are still viable.

DUTCH STANDARDS

Building Decree (Woningwet)

NEN 5128 “Energy performance of dwellings and residential buildings. Determination method”

NPR 5129 “Energy performance of dwellings and residential buildings” (practical guidelines)

NEN 2916 “Energy performance of non-residential buildings; Determination method”

NPR 2917 “Energy performance of non-residential buildings” (practical guidelines)

ITEMS ON THE ENERGY BALANCE SHEET

The determination method is limited to the items on the energy balance sheet that are building-related. The energy consumption for office equipment, catering, etc. is not included. User behaviour is standardised. The following items are included:

- heating: transmission, ventilation, heat gain (sun, inside heat), efficiency
- cooling: cooling requirements, heat gain (sun, inside heat), heat loss, efficiency
- ventilators
- pumps
- lighting
- hot water supply

The energy performance coefficient can be calculated with the following formula:

$$EPC = (Q_{\text{performance;total}} / Q_{\text{performance;permissible}}) \cdot EPC_{\text{requirement}}$$

$Q_{\text{performance;total}}$ numerical value of the characteristic energy performance in MJ primary energy. $Q_{\text{performance;total}}$ can be calculated as the sum of fossil fuel consumption for heating, ventilators, lighting, pumps, cooling, humidification and hot water supply.

$Q_{\text{performance;permissible}}$ numerical value of the permissible characteristic energy performance in MJ. $Q_{\text{performance;permissible}}$ can be calculated on the basis of an empirical formula. For a building with only one building function, $Q_{\text{performance;permissible}}$ is equal to $330 \cdot A_g$, where A_g is the surface area in use.

The rest of this paper will only discuss the primary energy consumption for lighting as part of $Q_{\text{performance;total}}$.

PRIMARY ENERGY CONSUMPTION FOR LIGHTING

The energy consumption for lighting must be determined on the basis of the capacity of the installed light fittings, the hours the lights are on and the control equipment. To make the calculation, an area is divided into a daylight sector and an artificial light sector. Provided the lighting sys-

tem in the daylight sector is switched separately, certain lighting control systems can be assigned a higher value than in the artificial light sector. The calculation rules laid down for determining the values for the daylight and artificial light sectors depend on the position and dimensions of the daylight apertures and the translucence factor (LTA) of the glazing.

The primary energy consumption for lighting can be calculated with the following formula (since this paper is only intended to illustrate the essence of the determination method, the formulas have been simplified):

$$Q_{\text{primary;lighting}} = 10.9 \cdot (E_{\text{lighting;daylight sector}} + E_{\text{lighting;artificial lighting sector}}) \quad [\text{MJ}]$$

$Q_{\text{primary;lighting}}$ is the primary energy consumption for lighting [MJ]
 E_{lighting} is the electrical energy consumption for lighting in the daylight or artificial light sector [kWh]

10.9 conversion factor from kWh_{el} to MJ primary energy

The electrical energy consumption for the *daylight sector* during the day period can be calculated as follows:

$$E_{\text{lighting;daylight sector}} = P_{\text{lighting}} \cdot f_{\text{control;daylight}} \cdot (A_{\text{daylight sector}} / A_{\text{surface area in use}}) \cdot t_{\text{day}}$$

P_{lighting} total installed load for lighting, including ballast [kW]

$f_{\text{control;daylight}}$ factor for the control/switching system (see table)

$A_{\text{daylight sector}}$ surface area of the daylight sector [m²]

$A_{\text{surface area in use}}$ surface area in use in the building [m²]

t_{day} number of burning hours per year in the day period

The electrical energy consumption for the *artificial light sector* during the day period can be calculated as follows:

$$E_{\text{lighting;artificial light sector}} = P_{\text{lighting}} \cdot f_{\text{control;artificial light}} \cdot (A_{\text{artificial light sector}} / A_{\text{surface area in use}}) \cdot t_{\text{day}}$$

P_{lighting} total installed load for lighting, including ballast [kW]

$f_{\text{control;artificial light}}$ factor for the control/switching system (see table)

$A_{\text{artificial light sector}}$ surface area of the artificial light sector [m²]

$A_{\text{surface area in use}}$ surface area in use in the building [m²]

t_{day} number of burning hours per year in the day period

The electrical energy consumption during the evening period can be calculated as follows:

$$E_{\text{lighting;evening}} = P_{\text{lighting}} \cdot f_{\text{lighting evening}} \cdot t_{\text{evening}}$$

P_{lighting} total installed load for lighting, including ballast [kW]

$f_{\text{control;evening}}$ fraction of the maximum energy consumption for lighting in the evening/night period (0.5 to 0.8)

t_{evening} number of burning hours per year in the evening period

Table 1: $f_{\text{control;artificial light}}$ and $f_{\text{control;daylight}}$

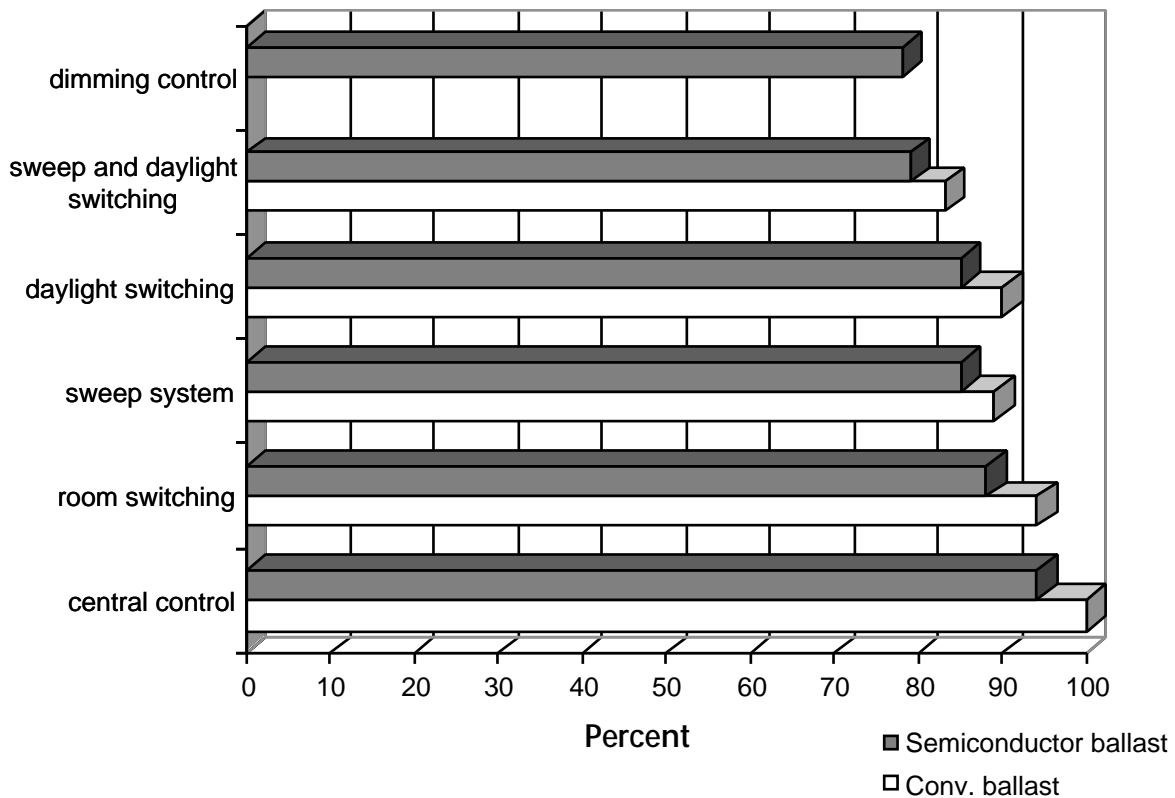
Definition of control system	$f_{\text{control;daylight}}$	$f_{\text{control;artificial light}}$
central control	1.0	1.0
room switching (switch per room)	0.7	0.9
lighting sweep system	0.7	0.7
daylight switching (outside sensor)	0.4	0.9
sweep and daylight switching	0.2	0.7
dimming control	0.2	0.6

Table 2: Relative effect of the lighting system on the energy performance coefficient

Definition of control	Conventional Ballast	Semiconductor Ballast
central control	100%	94%
room switching (switch per room)	94%	88%
lighting sweep system	89%	85%
daylight switching (outside sensor)	90%	85%
sweep and daylight switching	83%	79%
dimming control	-	78%

If the glazing used has a sun-reflecting coating, the effect of daylight switching and dimming control is less than indicated in the table.

Relative effect of lighting system on the energy performance coefficient



SAMPLE CALCULATION

For an office building of 3600 m², the following calculations for otherwise standardised preconditions are intended to illustrate the valuation of energy-efficient lighting systems.

A_{floor} 3600 m²

Glazing: double glass.

Daylight sector: 38% for the offices; 36% for the canteen; 46% for the hall and 100% for the stairs (when sun-reflecting glass is used, the daylight sector no longer applies and the reduction by sophisticated control equipment is no longer valid as a result).

Lighting capacity: 12.5 W/m² for conventional ballast and 10 W/m² for HF lighting.

Table 2 shows the effect on the energy performance coefficient of the choice between fluorescent lighting with conventional (electromagnetic) ballast and high-frequency semiconductor ballast, and of various types of control equipment.

This sample calculation shows that the lighting system has a substantial influence on the energy performance of a building. We may therefore assume that, given the periodical tightening of the energy performance requirements, the innovation of the standardisation contributes to the use of sophisticated, energy-efficient lighting systems.

This will also be facilitated by related stimulation measures. Until the end of 1996, energy companies gave a subsidy on fluorescent lighting with semiconductor ballast. At the moment, this subsidy is limited to daylight-dependent dimming control. A lighting system with semiconductor ballast and daylight dimming control is eligible for a tax subsidy (EIA; approximately 15%).

Furthermore, Novem stimulates the use of energy-efficient lighting systems by means of public information and the transfer of knowledge. In September 1997, a large-scale promotion campaign for daylight dimming was started. This campaign is being run in association with suppliers, who act as ambassadors for daylight dimming when promoting their products. This is expected to cause the use of daylight dimming to become as popular in a few years as fluorescent lighting with semiconductor ballast. ●

REFERENCES

- “Energy Performance of Non-residential Buildings. Determination Method”, NEN 2916 (1994)
- “Introductiebrochure EP&NEN” (Introduction Brochure), Novem (1995)
- “De Energieprestatienorm en verlichting” (The Energy Performance Standard and Lighting), TNO (1995)
- “Dat licht zo!!!” (See the Light!!!), Novem (1994-1997)
- “Daglichtafhankelijke verlichting. Dat regelt zich vanzelf” (Daylight-Dependent Lighting. It controls itself), Novem (1997)