LIGHTING TARGETS IN SWISS REGULATION AND LABELS: WHAT WOULD IT TAKE TO CHANGE?

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ABSTRACT

Switzerland has long been regarded as a pioneer in the field of lighting, especially for daylighting. It may be recalled for example that in the 80's, the Swiss Association for Lighting was the first to propose the concept of daylighting autonomy. Furthermore, one cannot ignore the deep involvement of EPFL in the development of daylighting methods and tools since the early 90's.

However, the use of natural lighting is hardly fostered by the current Swiss building regulation and that the trend for lighting is mainly concentrate on the use of high performance luminaires and advanced lighting control. Moreover, the present regulation can even lead to paradoxical situations such as, for example, a windowless room is more likely to fit with the standard than if it is equipped with large openings.

Daylight is renewable energy, and to achieve the objectives of a sustainable society, it is imperative to use its maximal potential. This is particularly relevant if one considers that the part of lighting in the building energy consumption is increasingly important.

This paper points out these limits of the Swiss standard through the study of five particular examples. It concludes with some proposals for improvements and suggests taking advantage of the latest developments in design & simulation tools which are now available on the market.

Keywords: Daylighting, Swiss standard.

INTRODUCTION

The Swiss regulation for lighting is primarily governed by the SIA-380/4 standard [1] and the technical specifications described in SIA-2024 [2]. These documents are part of the Swiss policy to reduce electricity consumption in the building. The principle of this standard is to use approximation rules in order to give an estimation of the lighting electricity consumption. The most influential parameters are aggregated to produce weighting factors. Current records date from 2006 and a new version of the documents is currently in preparation. The time is right for commenting on the flaws of the current regulations so that the new version could be improved. This paper particularly highlights four major areas of improvement:

For each point, we examine typical examples illustrating the potential for improvement. The proposed arguments are based either on in-situ observations, or on simulations performed using the DIAL+*Lighting* software [3]. In each case, we make some proposal for improving the new version of the standard.

ELECTRIC LIGHTING

In general, the current standard is largely focused on the performance of the electric lighting systems. It sure encourages developers to use efficient sources and high-efficiency luminaires, which is certainly appropriate. In addition, the standard also recommends implementing automated systems to manage the luminaires' switching. Among them, the Auto-ON-OFF system is particularly valuated in that standard as it grants them a potential 40% reduction in electricity consumption. This system is supposed to help the user to reduce the operating time of electric lighting by comparing the available illuminance (I_a) to the recommended illuminance value (I_r).

- If $I_a < I_r$: lights are switched ON
- if $I_a > I_r$: lights are switched OFF

A recent study conducted by the authors [4] tends to show that in office buildings, when daylight declines, users will light up the lamps when the illuminance level on their workstation is far below 500 lux. Figure 1 shows that half of the observed offices were not using electric lighting with an average daylight contribution lower than 156 lux. Such an observation leads us to believe that automatic triggering of lamps certainly supports the reduction of electricity consumption, but the automatic ignition most likely results in an increase of this consumption.

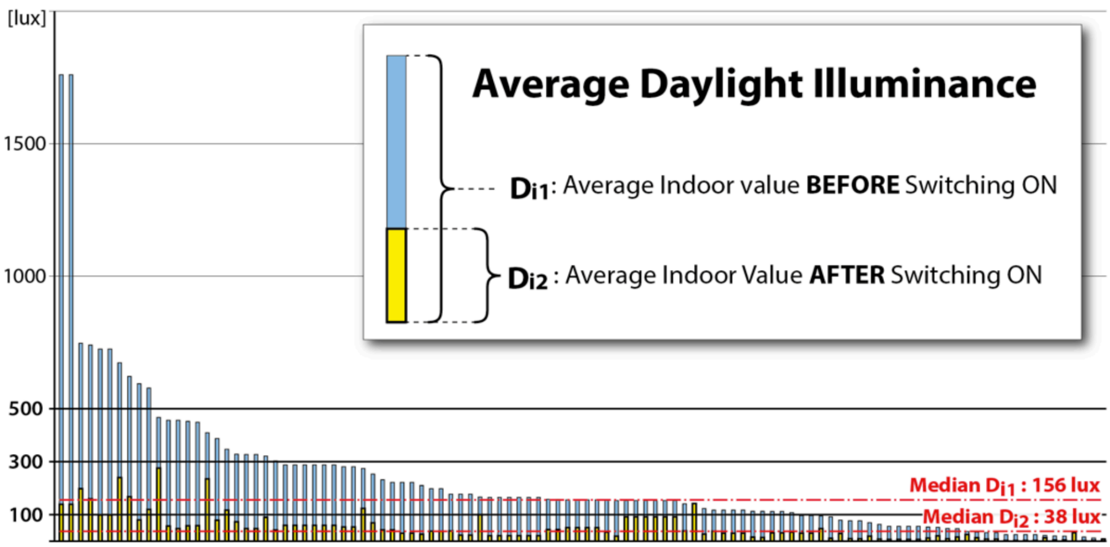


Figure 1: Average daylight illuminance before (blue) and after (yellow) that the occupants decided to switch-on the light [4].

We therefore recommend that in its new version, the standard discourages the Auto-ON systems for electric lighting .

DAYLIGHTING

Glazed area

Until now, there has never been any specific quantitative requirement for natural lighting in the Swiss regulation. This does not mean that this aspect is not treated, but the way to approach it is to calculate the lighting electricity consumption by taking into account a few isolated settings. As many other energy topics, lighting evaluation follows the structure of the Swiss building regulation, namely, according to its physical characteristics and its allocation, a *limit* value and a *target* value (*limit*: not to be exceeded; *target*: can be achieved if good practices applied) are assigned to each room. Table 1 below shows that the current settings of the standard clearly favour a very poor glazed room (left) that can even reaches the Minergie label, while a strictly identical room with a large window cannot. The problem here lies in the fact that the limit and target values are shifted depending on the glass surface. The more the room is glazed, the more the standard is demanding. This runs counter the spirit of the law that should favour the reduction of the energy consumption through the implementation of significant glazed areas.

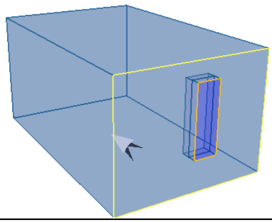
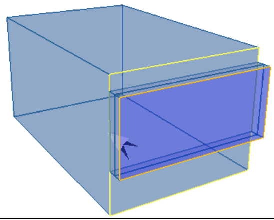
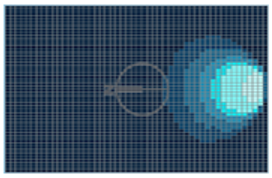
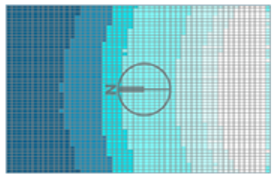
Axonometric		
DF Distribution		
Window to Floor Ratio	4%	27%
Average DF Value	0.6%	5.0%
Limit Value SIA 380/4	49.3 $kWh/m^2.y$	9.8 $kWh/m^2.y$
Target Value SIA 380/4	28.4 $kWh/m^2.y$	32.6 $kWh/m^2.y$
Limit Minergie	33.6 $kWh/m^2.y$	15.5 $kWh/m^2.y$
Project Value	31.2 $kWh/m^2.y$	17.6 $kWh/m^2.y$
Minergie Achieved	YES	NO

Table 1: Comparison of the lighting performance of two identical rooms respectively equipped with a very small (left) or a large opening (right) (DIA+Lighting simulations).

We therefore recommend that the new version of the standard takes into account the actual contribution of daylight. A shift in thinking is necessary: determining clear objectives linked to the room use, instead of movable targets, so that the designer is encouraged to optimize the effective room performance. In the event of these changes would not be applied, it would be in the public interest that the Minergie label, which is the reference in Switzerland, free itself from the law and imposes specific daylighting targets.

Reflection coefficients

As an extension of the foregoing, it is important to note that, concerning the reflection coefficients of the indoor surfaces, the current standard only considers the three combinations mentioned in Table 2 below.

Lightness sets	$\rho_{Ceiling}$	ρ_{Walls}	ρ_{Floor}	Weighting coef.
“Light”	0.8	0.5	0.3	1.0
“Normal”	0.7	0.5	0.2	1.1
“Dark”	0.3	0.3	0.1	1.5

Table 2: Description of the three sets of reflection coefficients described in the norm and the corresponding weighting factors

The weighting coefficients are used to modulate the forecasted annual lighting electricity consumption. For example, if the room is “dark”, the electricity consumption will be multiplied by 1.5. The two first sets are very close to each other while the last one is very pessimistic. In day-to-day practice there is a high probability that the room parameters are outside this range and that, to simplify, people tend to select the “Normal” set.

On this particular point, we recommend that the new standard leaves these sets and ask for independent values for each reflection coefficient. Furthermore, lighting simulations should be required in order to take into consideration the effective impact of these parameters.

Façade vs. Roof windows

Another weak point of the existing situation lies in the distinction between façade and roof apertures. Once the glazed area of a given room is described, the standard asks to select between façade or roof openings, and this choice will affect all the windows. There is no possibility to have a mix of façade and roof windows, and there is no specific distinction between horizontal, tilted and vertical roof openings. According to the standard, the selection of roof openings ends to a 25% reduction of the lighting electricity consumption. Experience teaches us that the performance gap between roof and facade openings is significantly higher, as it is shown in the example presented below (see Table 3).

Here again, we believe that this approach should be changed to be more representative of the various possible design solutions.

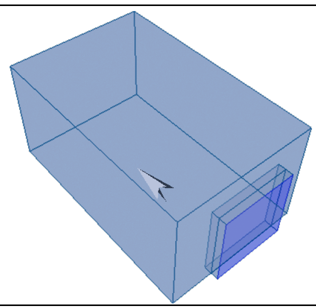
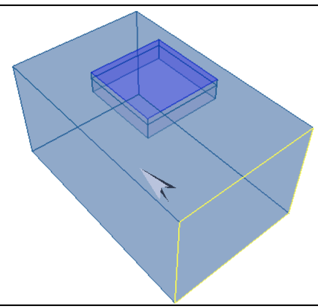
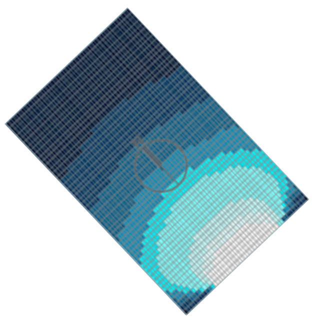
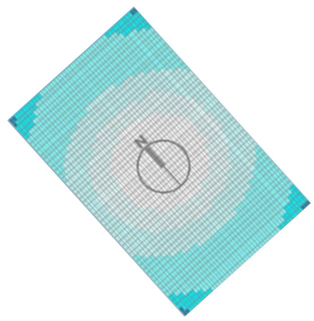
Axonometric		
DF Distribution		
Average DF	2.3%	6.3%
Lighting Electricity consumption according to SIA	41.4 kWh/m^2	33.6 kWh/m^2

Table 3: Comparison of the lighting performance of two identical rooms respectively equipped with a facade (left) or a roof aperture (right) (DIAL+Lighting simulations)

Shading devices

As shown in Table 4 below, the Swiss standard only proposes three options to describe the shading devices. This classification makes a mix between different parameters and it is quite difficult to find out where to stand. For example where should we locate "*white automated fabric blinds*" in this table?

Category	Type	g coef.	Lightness	Weighting coef.
Degree 1	Automated blinds	$g \leq 0.4$	Very light: $\rho_{slats} > 0.60$	1.0
Degree 2	Manual venetian blinds	$0.4 \leq g \leq 0.6$	Light: $0.4 > \rho_{slats} > 0.60$	1.1
Degree 3	Fabric blinds	$g \geq 0.6$	Dark: $\rho_{slats} < 0.40$	1.4

Table 4: Description of the three blinds categories that are considered in SIA-380/4, and their corresponding weighting coefficients.

Certainly the impact of blinds on lighting is very difficult to consider to the extent it highly depends on the user and / or automatism and thus requires performing complex simulations. Nevertheless, the new standard should at least, clearly distinguish the different influencing parameters, as suggested in Figure 2, in order to be able to better characterize the possible solutions.

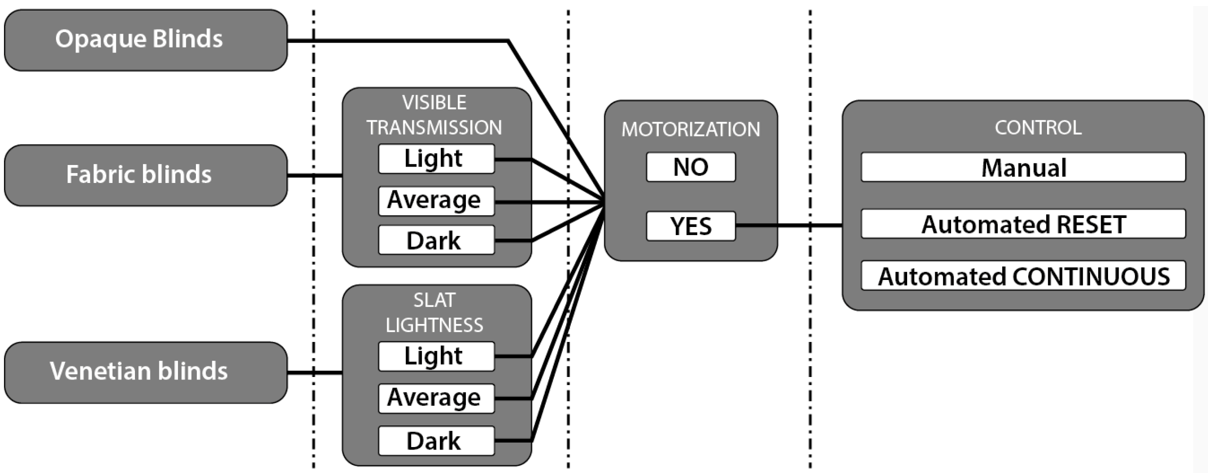


Figure 2: Schematic description of the minimum parameters that should be taken into account for the blinds description.

CONCLUSION

As shown in this paper, the Swiss standard lies on simplified algorithms aiming at processing a whole set of critical parameters. The main focus is on the estimation of the lighting electricity consumption, which is calculated by the mean of weighting coefficients. Examples presented here show that this approach can lead to a very rough approach of the lighting performance and sometimes even encourage poor design solutions.

Experience shows that energy consumption is strongly related to user behavior and the differences between forecasts and reality are often very important. We believe the time has come to radically change this approach. Today numerous tools are available on the market that allow performing detailed analysis on both electric lighting and daylighting. The new version of the standard should be built on these tools in order to require a specific analysis of the lighting potential of each project.

Regarding electric lighting, this potential should be examined through the performance of the equipment, the installed power, and the control system. This should be supplemented by simulations showing the illuminance levels provided by the installation, in order to check that the dimensioning is correct.

Regarding daylighting, the potential should be checked through numerical simulations allowing to have quantitative and geometrical information on the daylight availability. Considering recent advances in simulation, we have the choice between several metrics.

The simplest one, is daylight factor (DF). Although this concept conceals serious limitations (no influence of orientation nor localisation), it nevertheless enables to make a fast approach of the daylighting performance of a given room and is appropriated in the early design stage.

Another option is to switch directly to daylight autonomy (DA)[5] or spatial daylight autonomy (sDA)[5]. Considering that these metrics imply hourly simulations and that, for each time step, an information about the position of the solar protection is required, the uncertainty of the results is still important. We thus believe the effort is probably disproportionate.

Another possibility would be to use climatic data in order to convert DF values into Diffuse Daylight Autonomy (DDA)[6]. Besides the fact that this method allows to take into account the location and the orientation of the project, it also has the advantage of being very fast and thus remains compatible with the design phase.

We recognize that achieving simulations requires a significant additional effort and that it may be difficult to integrate this demand into the regulation. However, it would be helpful if the Minergie label fully assumes this theme. This requires to develop its initial approach,which mainly consists in designating the right position between the limit and target values defined by the standard.

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