

White paper

## Your office in a new light

Why you should consider light reflection in your next office build

**Sounds Beautiful**

# Why is the right light reflection so important?

Light is an essential part of our lives. We need it to see. We need it to remain physically and spiritually healthy. And light literally determines how we experience a space.

In this whitepaper, we explain the importance of the correct light reflection and light diffusion, with a matt white ceiling. We also show how the right light reflection can bring energy savings, boost work performance, enhance work conditions and improve comfort.

## The effect of light

The human body is deeply attuned to the natural cycles of sunlight. We are so affected by light that too little of it can bring on physical symptoms, like tiredness, headaches and eye fatigue. Too little light can even create psychological problems.

So shouldn't we use more artificial light? Even though the quality of artificial light has improved over the years, the healthiest and most comfortable light still comes from the sun. In fact, 77% of building owners identify natural light as the number one feature of a healthy building. Unfortunately, many buildings, like our offices and schools, offer very minimal natural light combined with too much artificial light.

When artificial light is improperly applied, it can have a sterile and uncomfortable effect. When a room is too brightly lit, for example, people become less focused, more tired, more easily distracted, and their tasks are performed less efficiently.

## Quality of the light

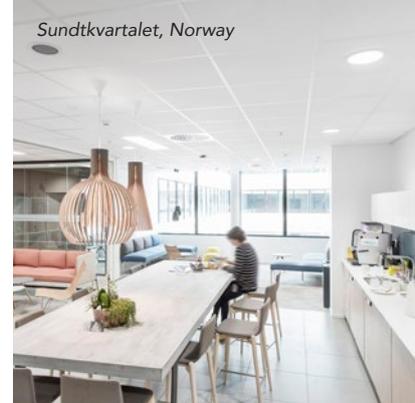
According to a 2009 study by Bauer et al, the quality of light depends on several inter-related factors: For the best quality light, spaces should be illuminated by as much natural sunlight as possible, with minimal use of electricity and artificial light. This natural light should be spread evenly through the room. And the impact of shine and glare — on screens, for example — should be reduced as much as possible.

Office workers prefer being near windows that provide good natural daylight, because it's satisfying and good for their health. This is especially the case if they do the kind of work that requires staring at a screen all day. Since digital screens constantly emit artificial light directly into the eyes, high-quality ambient light is becoming increasingly important to visual health.

The right light can stimulate us, relax us and improve our performance. Creating the quality light conditions also involves light reflection, which means that ceilings can play an important role in helping to spread natural light.



Sundtkvartalet, Norway



## Light reflection

Light reflection measures how much light is reflected by a surface, which we call the Light Reflectance Value (LRV). When a surface is illuminated by a light source, the LRV measures all light waves and directions reflected. LRV is measured as a percentage. For example, the reflection value of a mirror is 100%, and when there is no reflection at all, like with black velvet, then the value is zero. For the best quality, the direct light reflection should be at least 70%, while indirect light should be at least 80%.

If you have a space that needs more light reflected into it, often the best place to start is your ceiling. The ceiling is usually the largest unused area in any room. By working with high-quality ceiling panels, you can gain the benefits and health effects of both reflected light and artificial light.



## (The sound of wellbeing in a well lit building where you can focus without eyestrain.)

The diagram below represents an office with windows on both sides.

The top half of the graph shows how far the light is spread across a grey, concrete ceiling with a light reflection of 35%.

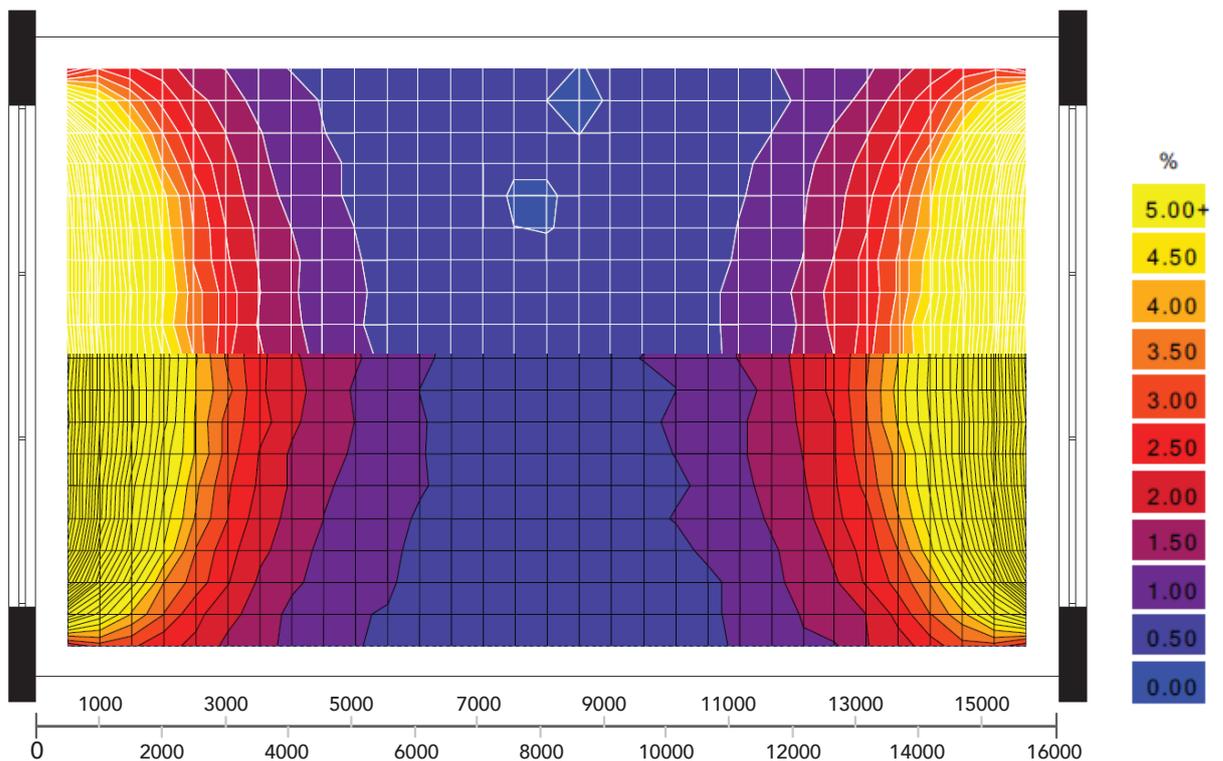
The bottom half of the graph shows how far the light reflects in the same room when the light reflection is improved to 87%.

The difference between the two is four meters in total, with two meters on each side.

Besides the distinction between artificial and natural light, there is also an important division between direct and indirect light. Direct light shines toward a certain area, so the light has one clear destination.

Direct light is therefore suitable for smaller surfaces. Indirect light, meanwhile, is the result of light reflection and requires a large surface. In this case, the reflection value needs to be as high as possible to make effective use of the light.

### Potential annual energy saving with 10 W/m<sup>2</sup> installed lighting power



Shows the outcome of a study on the distribution of natural light in a 16-meter office space.



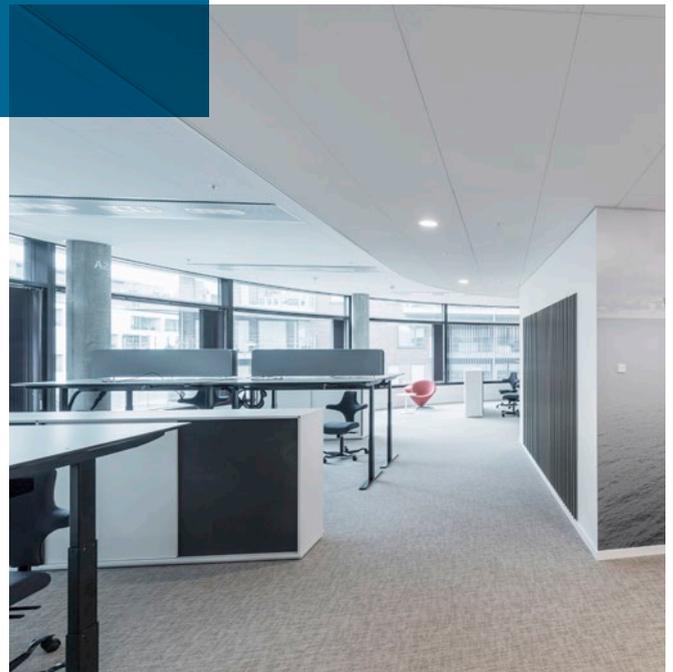
(The sound of calm in a building that reflects light to create a stress-free environment.)

## Subjective and objective factors

Lighting determines how we experience a space. In fact, it is often the only difference between perceiving a room as pleasant or unpleasant. So when we determine lighting criteria for a building, it's time to go beyond considering objective factors and functionality, (such as light reflection and distribution, energy efficiency and luminosity). It is just as important to consider subjective factors, such as the ambience. As an example, a high gloss ceiling is often perceived as "hard" and "cold", while a matte surface ceiling will radiate softness and give an entirely different atmosphere to the same room.

Subjective experience has a major impact on our wellbeing. A great example of this is the colour that is used on walls. According to a 2010 study by Oberfeld and Hecht, a bright ceiling combined with light walls influences our perception of the size of a space. Oberfeld and Hecht explain, 'if you are planning to make a room appear larger, paint both the ceiling and the walls in lighter colours.'

Similarly, a high LRV white reinforces that sense of space. The human brain associates a light space with a clear sky. Even though this seems only relevant to our subjective experience of a space, these feelings of largeness or bigness have additional benefits in terms of the room's functionality. For example, high light reflection from ceilings reduces energy consumption. This is because a high reflection supports the diffusion of daylight and optimises the yield of artificial light. Thanks to the reflection of the ceiling, the light is able to bounce from the ceiling to the walls and across the entire room. This even distribution means that fewer light fixtures are required, and as a result, lighting and electricity costs are reduced.

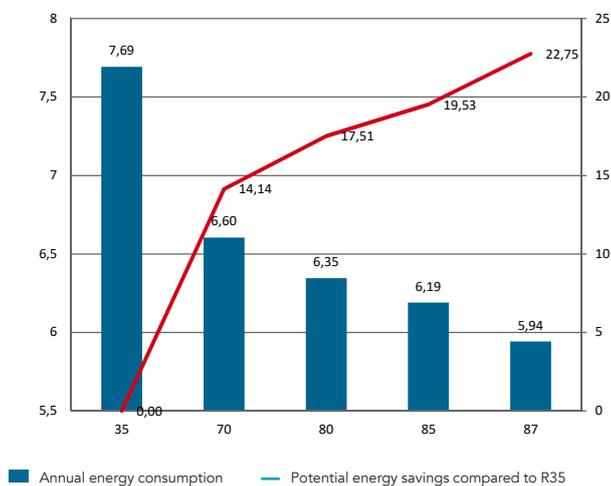


## Save energy costs

Ceiling panels with a high light reflection and a smooth, matte finish can draw daylight further into the building. In 2015, COWI researched ways to improve daylight levels in office spaces, finding that the right lighting and light reflection from the ceiling results in a lower energy bill. The figure below shows the energy consumption and energy savings of one ceiling, thanks to light reflection. The horizontal axis shows the light reflection improving from 35 to 87%; the vertical axis shows its energy consumption in kilowatt-hours per square metre per year (kWh/m<sup>2</sup>/year); and the blue line indicates the energy savings in percentages.

Ultimately, the research shows that a ceiling with a light reflection of 87% can result in energy savings of up to 22.75% per year.

### Potential annual energy saving with 10 W/m<sup>2</sup> installed lighting power



Energy consumption for electric lighting (kWh/m<sup>2</sup>/ye)

## Light diffusion and Retro-reflection

Light diffusion is what happens when incoming light is reflected in all directions. It creates an even spread of light and has no shadows, unlike light fixtures on the ceiling or fluorescent tubes. However, diffuse light on its own can create an empty atmosphere, so it works best when it is combined with direct and indirect light.

When done right, a room that combines light reflection with light diffusion does not need extra fixtures because light is naturally guided through the space. This is completely different to 'retro-reflection.' Retro-reflection is when incoming light is reflected back at a single angle, such as the white lines on the road or the reflective stripes on raincoats. This is not good for a ceiling. The higher the light diffusion, the lower the retro-reflection. A light diffusion >99% is best and eliminates the impact of retro-reflection.

## Benefits for everyone

In most public spaces finding the right combination between artificial and natural light can be a challenge, but it's not impossible. The best way to proceed is to have a lighting plan drawn up by an expert who understands the correct light reflection and light diffusion. It is also important to consider both subjective aspects of light, such as the perception of a particular atmosphere, as well as objective factors, like potential productivity and energy cost reduction.

Good quality lighting is worthwhile for all of us. It not only affects our wellbeing but can also performance and comfort.

### References

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**Rockfon**  
(ROCKWOOL A/S)  
Hovedgaden 501  
2640 Hedehusene

Tlf: 46 56 21 22  
Fax: 46 56 40 30  
[www.rockfon.dk](http://www.rockfon.dk)