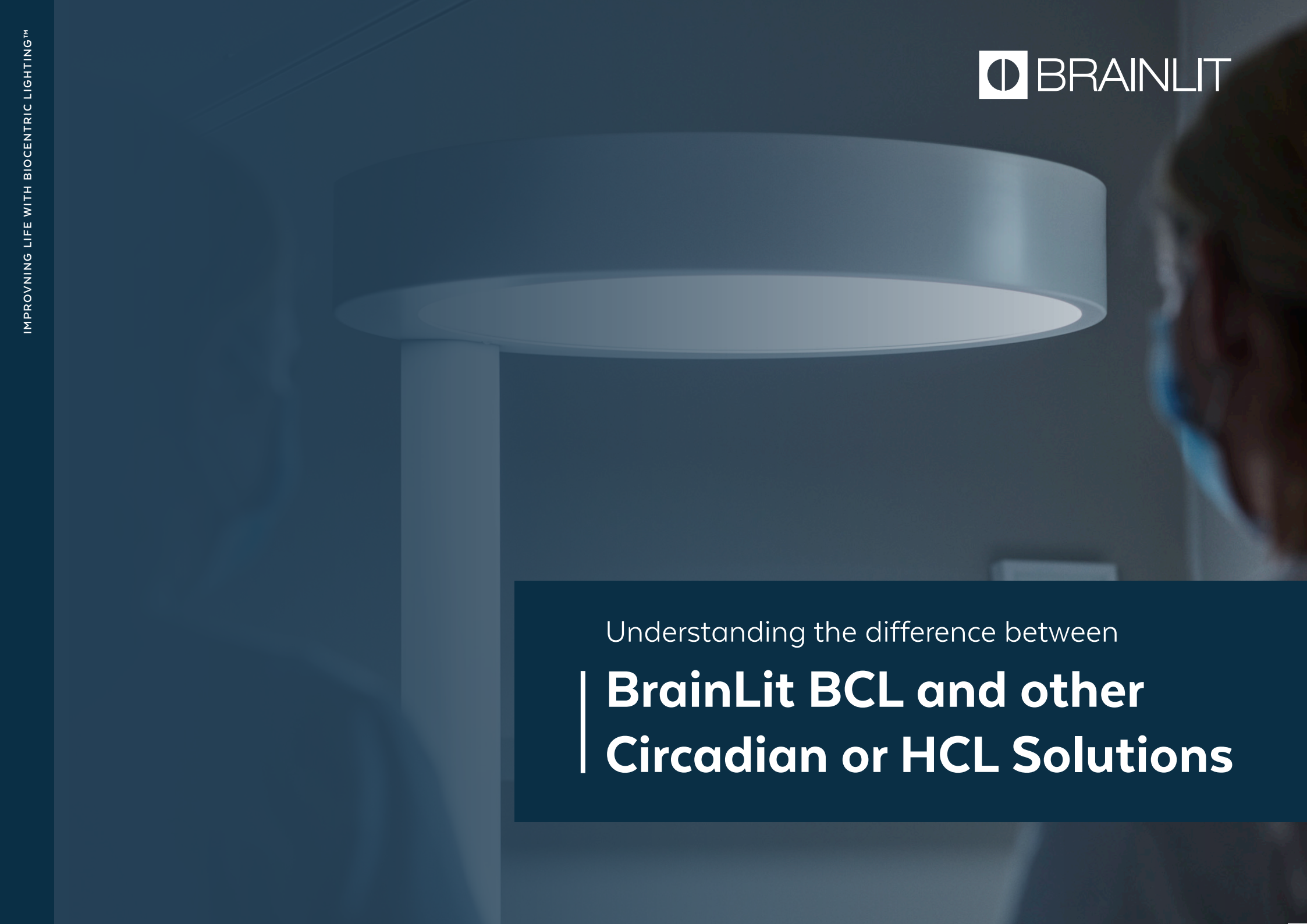
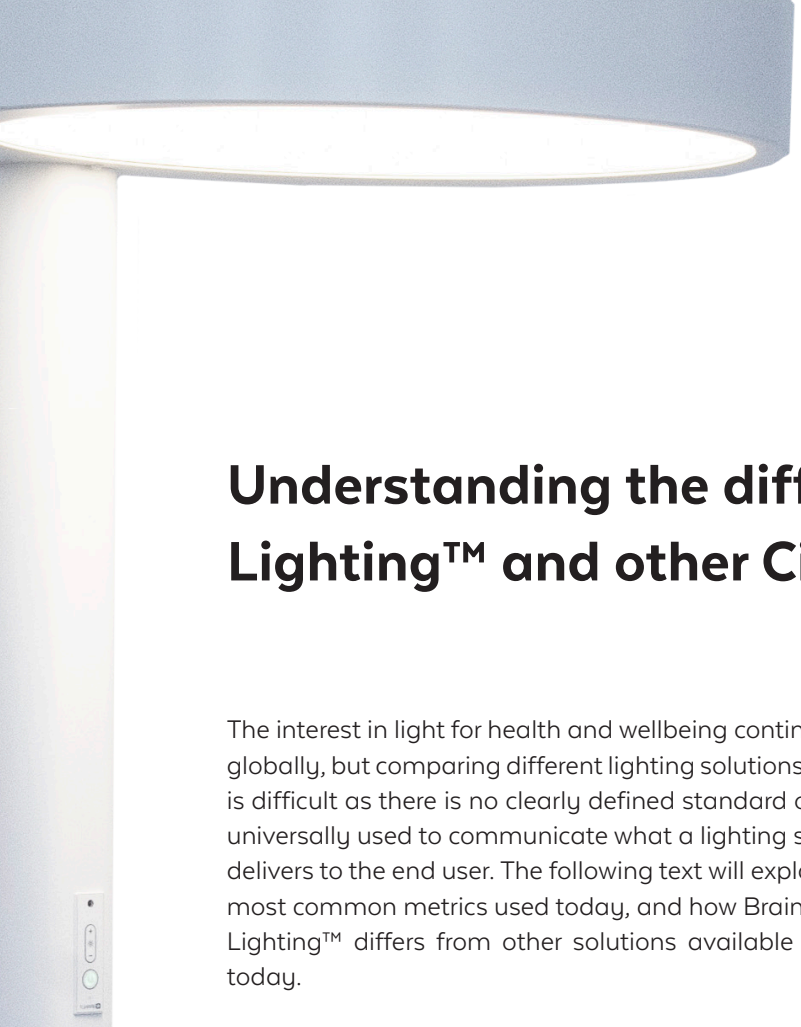
IMPROVNING LIFE WITH BIOCENTRIC LIGHTING™

BRAINLIT



Understanding the difference between

BrainLit BCL and other Circadian or HCL Solutions



Understanding the difference between BrainLit BioCentric Lighting™ and other Circadian or Human Centric Lighting Solutions

The interest in light for health and wellbeing continues to increase globally, but comparing different lighting solutions to one another is difficult as there is no clearly defined standard or metric that is universally used to communicate what a lighting solution does or delivers to the end user. The following text will explain some of the most common metrics used today, and how BrainLit's BioCentric Lighting™ differs from other solutions available on the market today.

The three most common circadian metrics used to measure and communicate the impact of light on one's circadian rhythm are: Equivalent Melanopic Lux (**EML**), Melanopic Equivalent Daylight Illuminance (**MEDI**), and Circadian Stimulus (**CS**). Different building and light standards use different metrics for the requirements on the light, hence the need for all three.

- **Equivalent Melanopic Lux** (**EML**) is a measure of how light stimulates your circadian system (stimulating melanopsin) compared to your visual system (photopic). EML is based on the illuminance at the eye (vertical lux) and the spectral properties of the light.

- **Melanopic Equivalent Daylight Illuminance** (**MEDI**) - Another measure of how light stimulates your circadian system compared to your visual system, based on vertical lux. However, includes an additional scaling depending on how the light source stimulates your circadian system in comparison to daylight, the melanopic daylight efficacy ratio (**DER**).

- **Circadian Stimulus** (**CS**) measures the impact from light exposure (both intensity and spectral properties) on melatonin level in the body. It takes it one step further than the previous two metrics and accounts for how the stimulation of melanopsin in the eye translates to a change in melatonin level in the body.

The Rensselaer Lighting Research Center, one of the world's leaders in studying light's impact on health and wellbeing, recommends a CS of 0.3 or greater for at least one hour in the early part of the day to sustain your natural circadian rhythm, while the building industry's WELL standard's highest requirement is 250lx MEDI.

In very general terms, a light source with a high Correlated Color Temperature (**CCT**) (i.e. "cold white") and high lx levels (i.e. high intensity) gives higher CS, and a light source with low CCT (i.e. "warm white") and low lx levels (i.e. low intensity) gives lower CS.

High color temperature (CCT) and high intensity (lx) gives a large circadian stimulus (CS).

Low color temperature (CCT) and Low intensity (lx) gives a lower circadian stimulus (CS).

During the daytime, individuals should want to receive light with a relatively high circadian stimulus, while during the evening and night times, individuals should want to receive light with a relatively low circadian stimulus.

The sensitivity of the circadian system is not the same at all times though. A specific CS during early mornings may advance your wakeup time, while if you receive the same light exposure in the late evening it would instead delay your natural sleep time and natural wake up time.

Neither CS nor MEDI account for the dependence on the timing of the light exposure. Other crucial time factors are exposure history and exposure duration, because they also influence sensitivity.

While CS and MEDI are controlled though luminaire performance and system design, the time related parameters in BrainLit's BCL are controlled through our patented light recipes. None of the circadian metrics above taken into account personal variation (Genetic differences: Age, Gender, Chronotype, Sensitivity to light, Desired Wake times) whereas our light recipes take into account these factors.

There are however many other perspectives to account for and many design parameters to consider.

For example, during daytime hours when an individual should receive light with a higher circadian impact, the energy consumption of a system may be higher in order to deliver sufficient lx levels, but in the evening, when you want to avoid circadian stimulus, you still need light to conduct your chosen activities while having minimal impact on your circadian rhythm.

BrainLit light systems are designed to deliver the right amount of circadian stimulus at the right time of day to help individuals maintain their natural circadian rhythm.

What makes BrainLit different from Human Centric Lighting (HCL) solutions?

There is no one standard for Human Centric Lighting. Every provider has its own definition for how it delivers HCL.

Tunable white luminaires, for example, have the ability to control the light source's color temperature output: for example, mixing cool and warm white light. So while a tunable white luminaire with a range of 2700-6500K may deliver the right color spectra, it disregards the dependencies on light intensity and timing of exposure. This can be because neither light intensity or timing of exposure are properties of the luminaire itself, they are properties of the system solution.

In tunable white luminaires, circadian metrics are rarely the primary design parameter. Instead, the color temperature is the focus. Color temperature alone, does not determine the impact on the circadian system.

With our luminaire specifications, BrainLit ensures that we always deliver light with a wide range of circadian impact from 0.18 to 1.08 DER. A DER close to one implies the light source stimulates your circadian system the same as daylight, a DER much less than one implies the light source stimulates your circadian system much less than daylight.

A typical range for tunable white (2700-6500K) luminaires, not specifically designed for the circadian system, may be 0.4 to 0.75 DER.

For example, BrainLit's standard ASK panel luminaire delivers a circadian stimulus that is even slightly higher than natural daylight (at the same illuminance level). All other BrainLit BioCentric Lighting™ luminaires are on par with natural daylight.

BrainLit systems also control exposure time as well as timing relative to the phase response curve, ensuring that energy consumption is maximized or minimized depending on the desired circadian effect.

BrainLit has also patented and is developing the capability to incorporate individual light exposure history, chronotype, and many other relevant factors to personalize our light recipes to meet individual biological needs. The BCL system will also soon allow you to move between different BCL light sources and take your personal light profile and recipe with you.

Why does BrainLit “over-deliver” on certain key metrics compared to natural daylight or other HCL competitors?

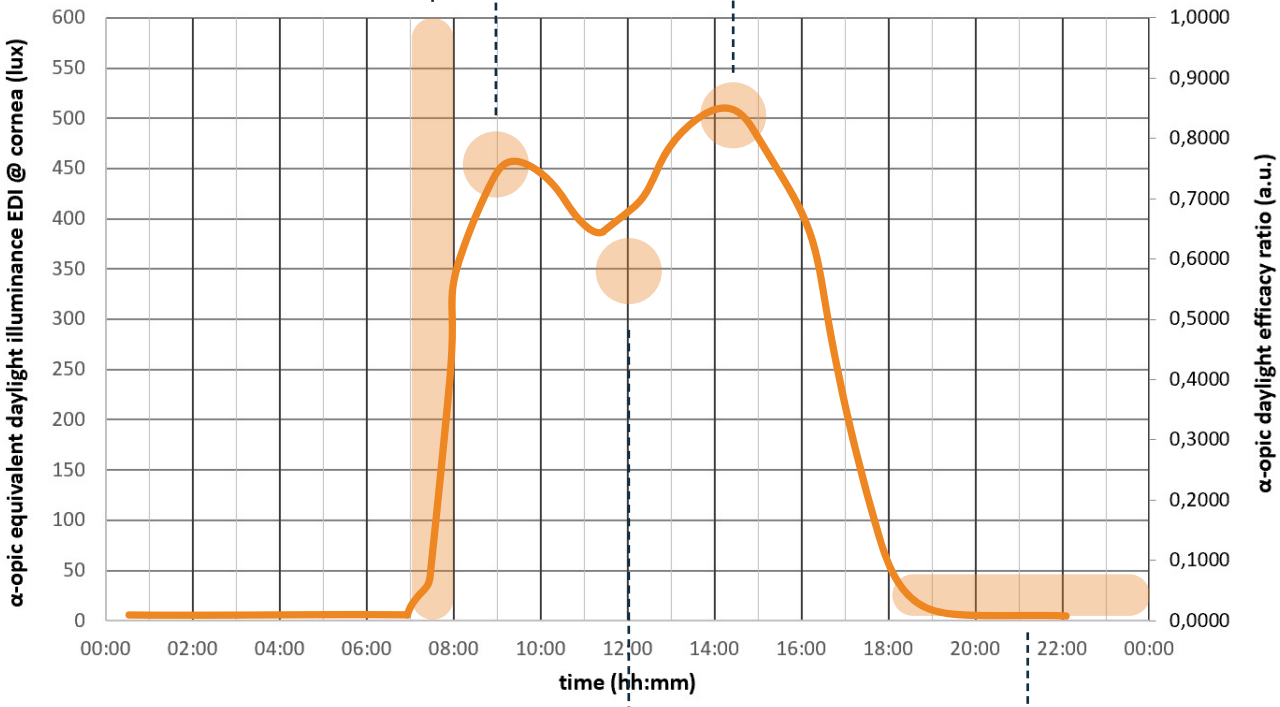
It is beneficial to surpass existing CS, DER, or WELL standards to be able to:

1. Affect a larger user population given that there are variations in individual circadian sensitivity.
2. Account for individuals who may not spend the recommended amount of time in BioCentric Lighting™.
3. Counterbalancing bad light exposure, for example receiving more light than needed during evenings.
4. Delivering a higher circadian stimulus and related health benefits than from lighting that just meets the industry norms.

Dawn simulation to trigger perception of the start of the day. Designed to start 30 min before wake-up time with slow gradual increase of intensity combined by a fast change in CCT to mimic the sun rising above the horizon.

Morning high circadian impact period to set the circadian phase to the desired wake up time. m-EDI is above 400lux for about 2 hours.

In mid day when circadian impact is less important the m-EDI is lowered to around 350 to save energy and relax eyes.



In the afternoon, around 2pm, the m-EDI rise to 450-500lux for about 2hours. Circadian stimulation at this time can counterbalance undesired circadian impact the user may experience closer to bed time.

Preparation for bedtime by strong reduction in circadian impact to facilitate melatonin onset with improved sleep quality. m-EDI stays below 10lux from 7pm.

Comparing with other solutions on the market
Leading European Lighting System Provider

Compared to one leading European provider of high quality lighting solutions in the healthcare sector, their high end circadian impact is DER=0,8625 while BrainLit's similar luminaire delivers DER=1,084. In other words, the light from the other provider's luminaires is **86%** as effective compared to natural daylight in stimulating the circadian system, while BrainLit's luminaire is **108%** as effective.

For a person who prefers a lower intensity visual light level, or someone who wants to lower energy consumption, this translates to being able to dim down the BrainLit BioCentric Lighting™ and decrease energy consumption while still maintaining the desired circadian impact. Alternatively, for a person who needs a larger circadian impact, this can be achieved without increasing the visible light intensity level.

Example competitor #1: **Leading European Healthcare lighting provider**

The competitor's low end circadian impact is DER=0,077 while for BrainLit the corresponding figure is 0,178 à 8% and 18% as effective respectively comparing to natural daylight. Looking only at this ratio could be seen as an advantage for our competitor, but they achieve this using a monochromatic light source while BrainLit use a full spectrum light source.

The color spectrum of the competitor product is consequently a fairly narrow peak with the CRI being very poor, around 58. BrainLit on the contrary is above 90 CRI the entire dynamic range from high, all the way to the low circadian impact limit. Thus the competitor's light source will generate very poor color representation while BrainLit's will be very good, which can be instrumental, especially in healthcare environments.

In light environments with a low CRI color representation, colors appear washed out and it is more difficult to make out contrasts. For example, it becomes more difficult to find blood vessels or base diagnoses on ocular inspection, and for patients or residents, food can appear less appetizing. BrainLit's exceptional 90+ CRI across the range of systems provides great color representation conditions.

Also very relevant is that the BrainLit low end circadian impact limit DER= 0,178 still enables the delivery of night light at 300 horizontal lux without exceeding the "no impact" limit according to Rensselaer LRC and Arbetsmiljöverket standards in Sweden, i.e. BrainLit's low limit circadian impact is sufficiently low to fit the purpose and application and in addition has a clear competitive advantage with full spectra light also at the low limit.

Example competitor #2 dynamic lighting desk lamp

The desk lamp in question, designed by a leading global consumer products manufacturer, is focused more on task efficiency than circadian impact. It has similar CCT and CRI as BrainLit Alven, but has a maximum lumen output of 1120lm, while BrainLit Alven has a maximum output of 6400lm and a corresponding 590lux MEDI at the suggested user position. BrainLit Alven can also get remote updates when needed, unlike the competitor product.

Example competitor #3 free-standing dynamic lighting standing lamp

The standing lamp in question, designed by a European lighting manufacturer, is focused on both task efficiency and circadian impact. Compared to BrainLit Alven, the standing lamp has a strong lumen output but a narrower CCT range and also a CRI/Ra of only around 80, whereas BrainLit Alven is always 90+ CRI/Ra.

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