

# Designing Lighting to Promote Better Sleep

Virginie Gabel<sup>1</sup>, Kevan Shaw<sup>2</sup>, Roger Sexton<sup>3</sup>

<sup>1</sup> Board member Good Light Group, PhD., Director of Clock&me

<sup>2</sup> Board member IALD, BSc. C.Eng (MILP) FIALD CLD MSLL

<sup>3</sup> Board member Good Light Group, FSLL

Case Study presented with support from James Sherman, Foster + Partners

# Topics

1. Sleep

2. Light

3. Lighting Design

4. Integrated lighting design example

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# What is sleep? 4

## STAGE 2 LIGHT SLEEP 10-25 min

- General slowing of brain activity and heart rate
- Body temperature drops
- Can be woken easily

## STAGE 3 DEEP SLEEP 20-40 min

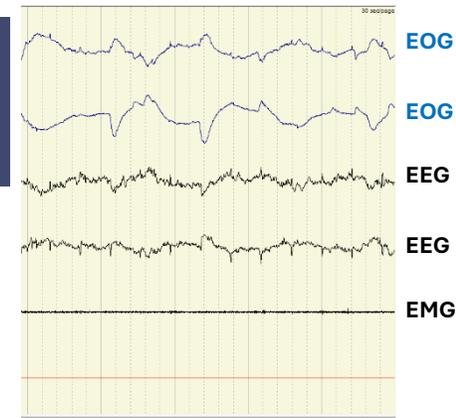
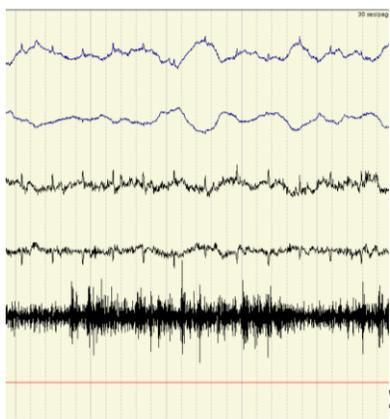
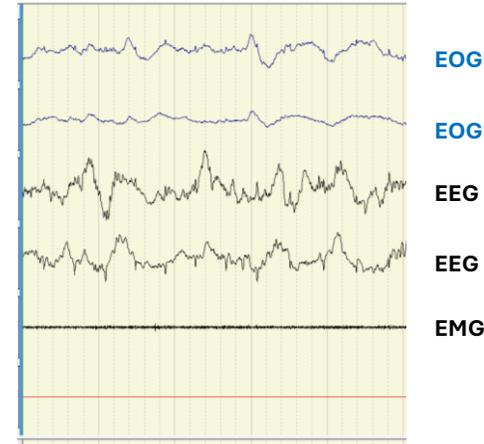
- Insensitive to surrounding noise
- Predominance of slow waves
- Very hard to be awoken
- Physical recovery, tissue repair
- Growth hormone released

## STAGE 1 DROWSY 5-10 min

- Sleep/wake transition
- Sensitive to surrounding noise
- Muscle relaxation begins
- Eyes rolling

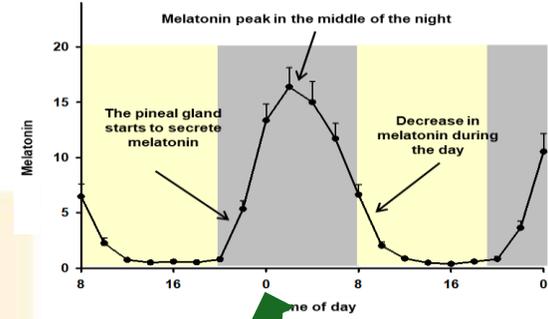
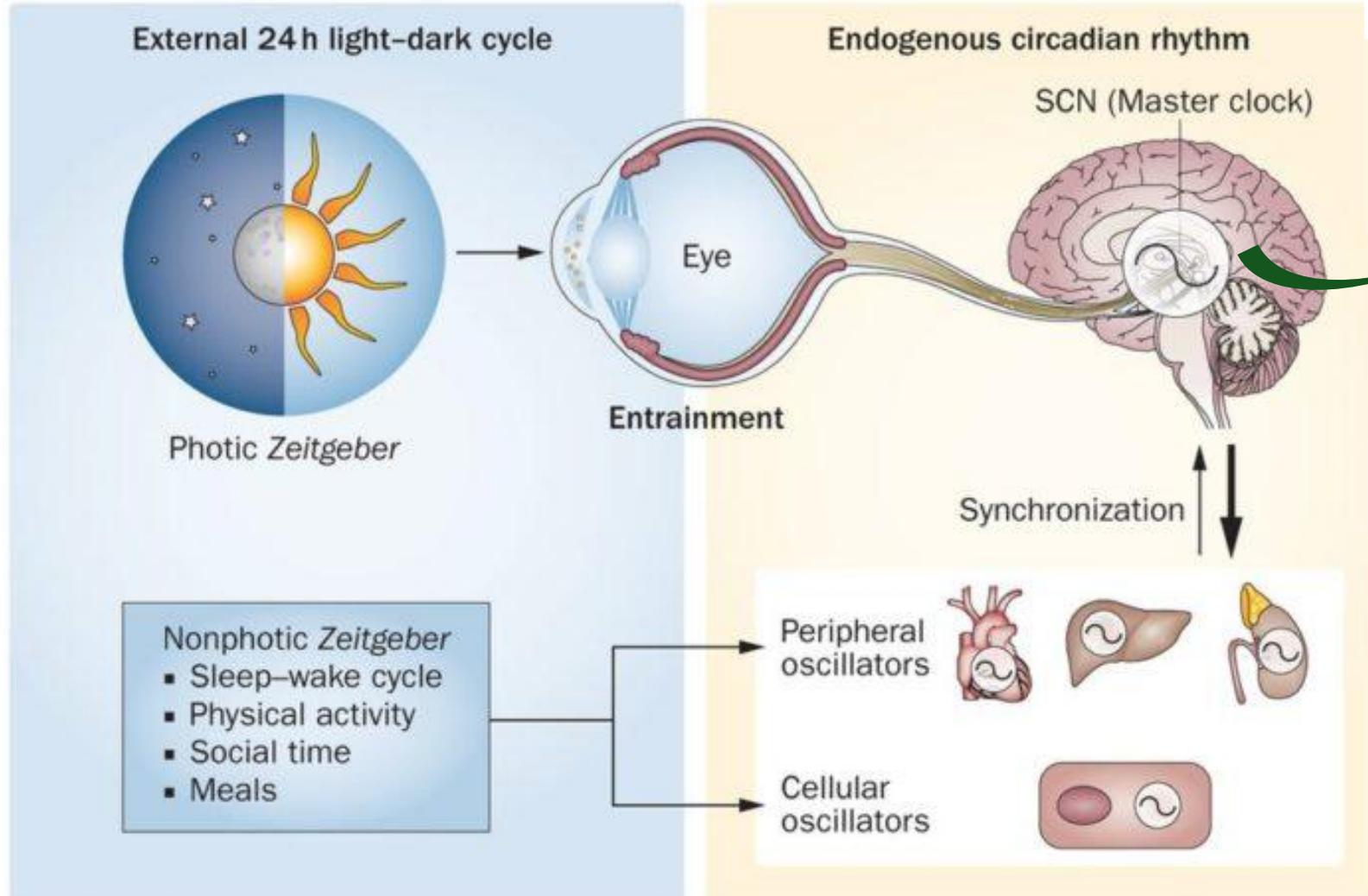
## REM PARADOXICAL SLEEP 20-40 min

- Rapid eye movements
- Lack of muscle tone
- Many dreams
- Memory and emotion processing



EOG : Electrooculogram  
EEG: Electroencephalogram  
EMG : Electromyogram

# Our internal clock - 2



From: Clocking in: chronobiology in rheumatoid arthritis, 2015, Buttgerit et al

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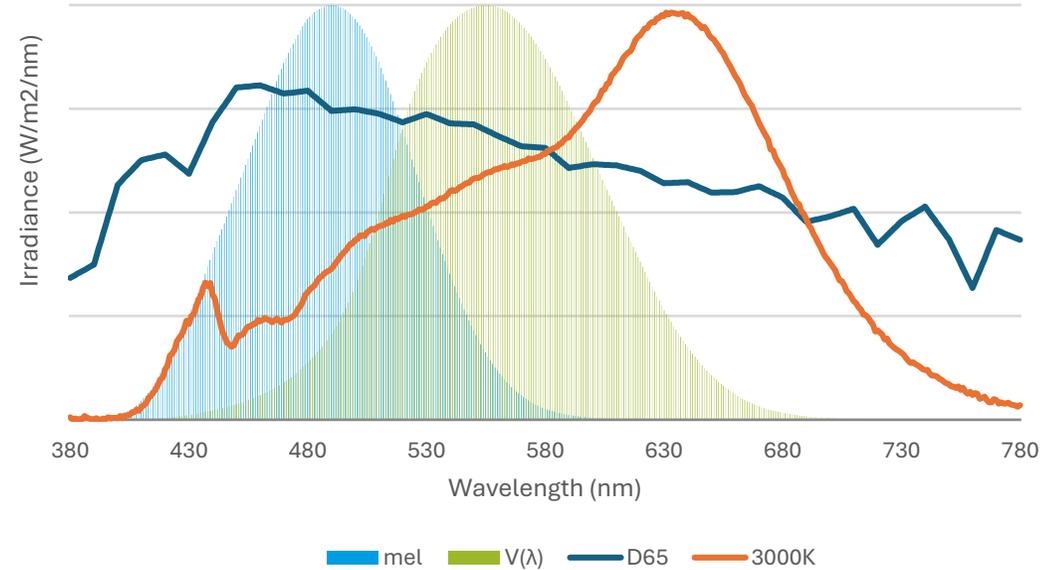
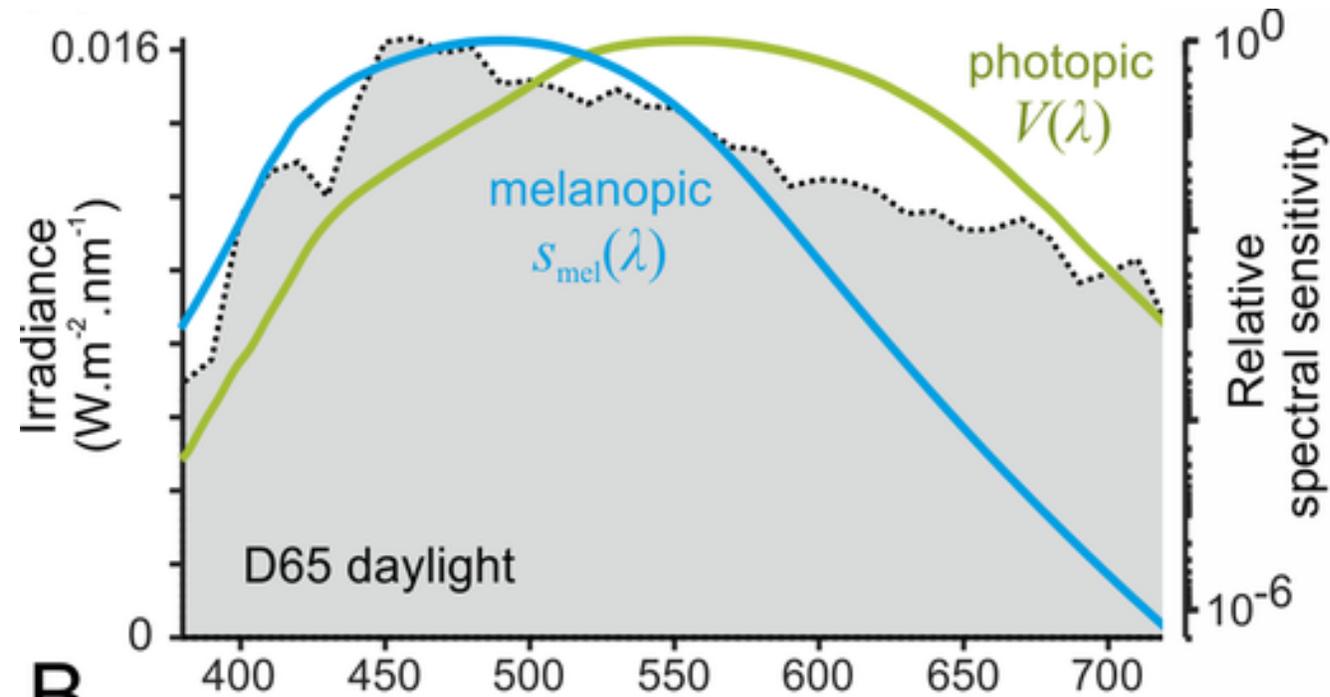


Too dim indoors by day,  
too bright at night

Much indoor lighting  
undermines our sleep  
and health

The right light at the  
right time supports  
sleep, alertness & health

# What are m-EDI lux?



B

**MELANOPIC EQUIVALENT DAYLIGHT ILLUMINANCE (m-EDI)** represents the illuminance produced by a lamp's radiation relative to standard daylight that provides an equal melanopic irradiance



# Conclusion: this is good light

- Throughout the daytime: **250 m-EDI lux**, vertical, minimum
- During the evening, starting at least three hours before bedtime: **10 m-EDI lux**, vertical, maximum
- The sleep environment should be as dark as possible: **1 m-EDI lux**, vertical maximum

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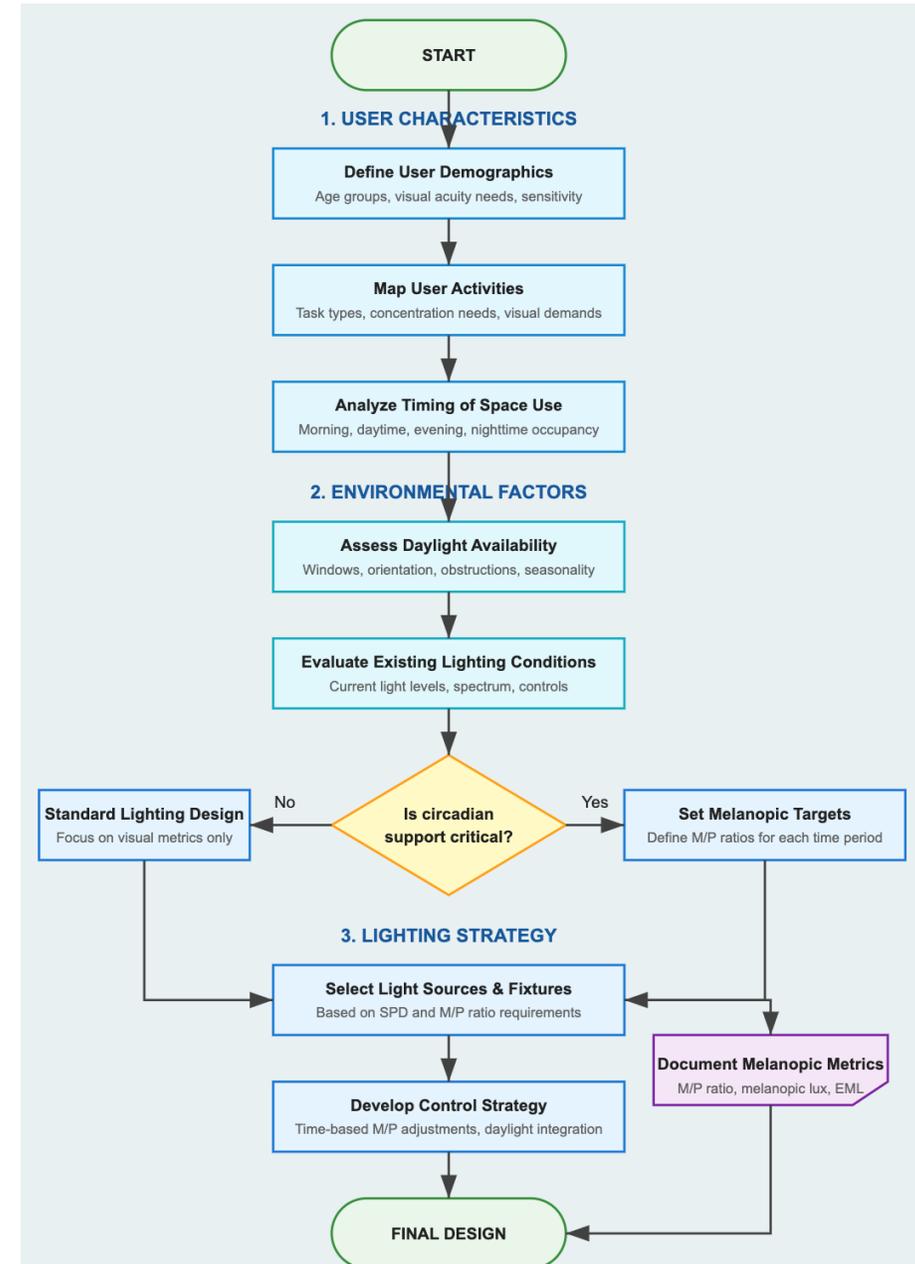
**3. Lighting Design**

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# Integrative Lighting Design

- Light for visual task performance
- Light for non-visual effects = Integrative Lighting

# Integrative Lighting Design Process



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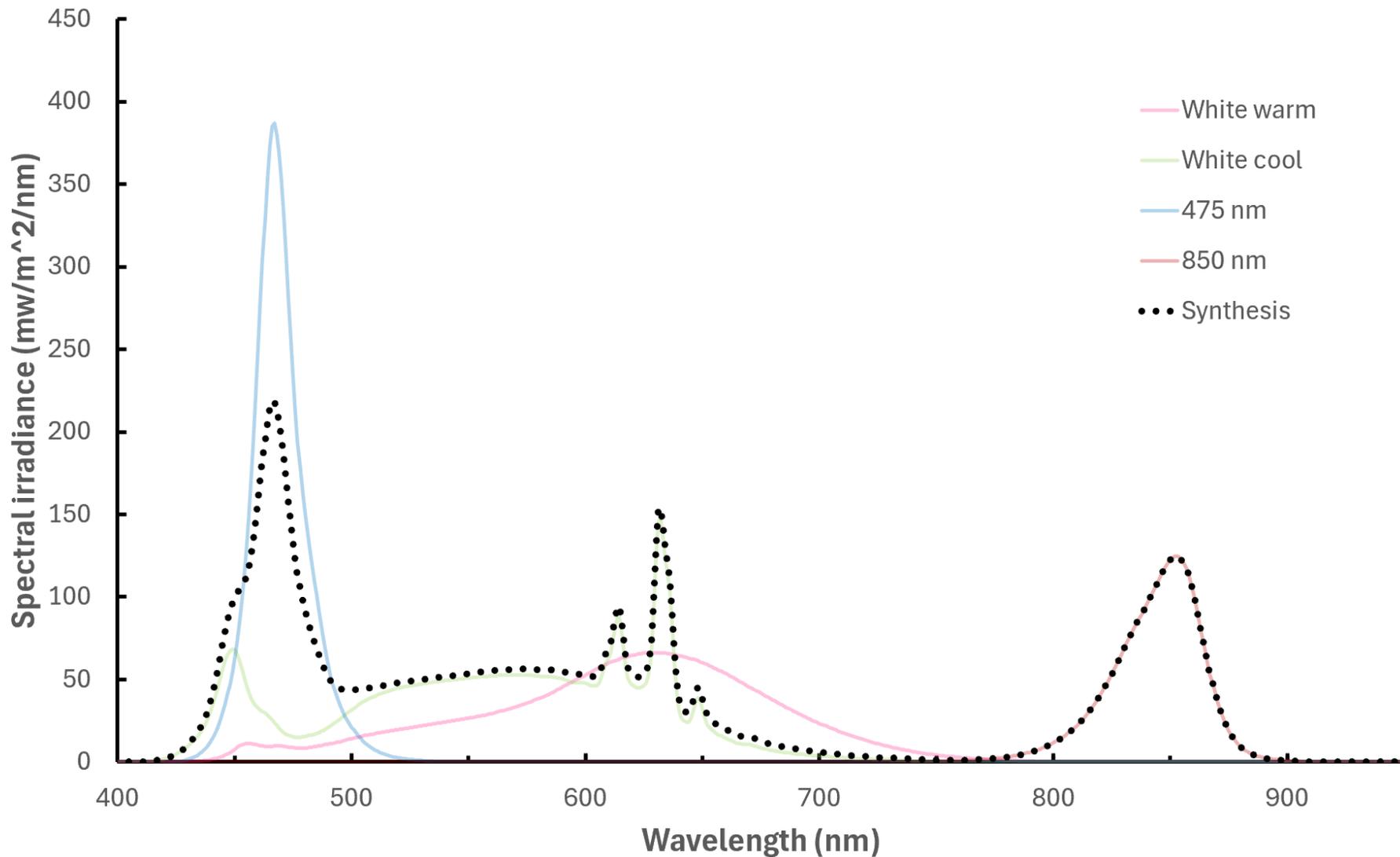
**4. Integrated lighting design example**

10am





Spectral Power Distribution, General Lighting (Overhead Linear Fixtures)



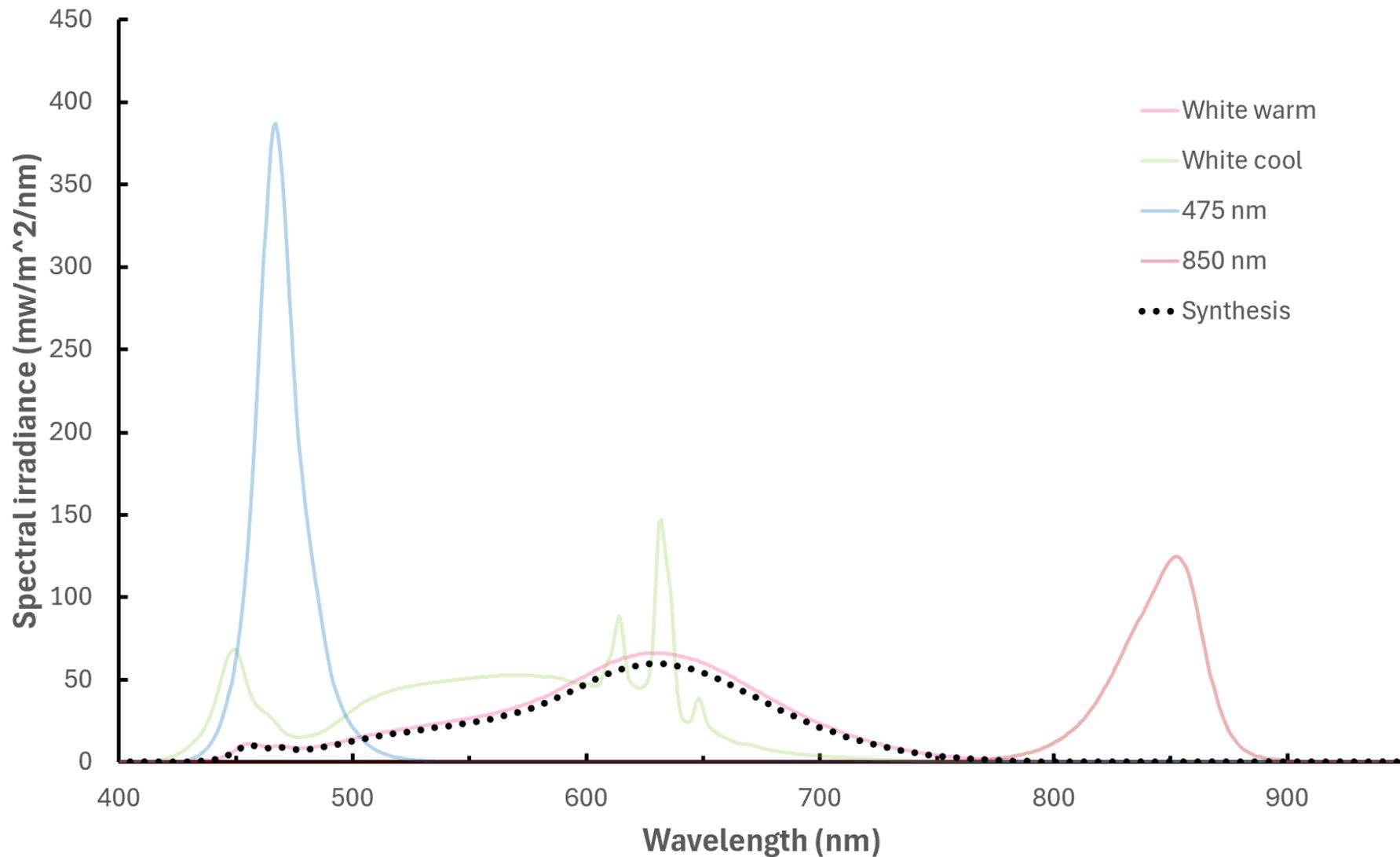
5pm





5pm

### Spectral Power Distribution, General Lighting (Overhead Linear Fixtures)



# Designing Lighting to Promote Better Sleep

1. Sleep is crucial for health
2. Light does much more than enabling us to see, it (de)regulates our day-night rhythms and sleep quality
3. Indoor lighting is often too dim during the day and too bright in the evening, which hampers entrainment of day-night rhythms
4. Integrative indoor lighting designs should support the circadian needs of users of buildings, as well as the visual needs
5. Case studies show that this is possible to realize.



# Good Light Group

[www.goodlightgroup.org](http://www.goodlightgroup.org)

[info@goodlightgroup.org](mailto:info@goodlightgroup.org)

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