

Building the evidence on light and human health

Bob Davis, Ph.D.

Pacific Northwest National Laboratory

Ron Gibbons, Ph.D.

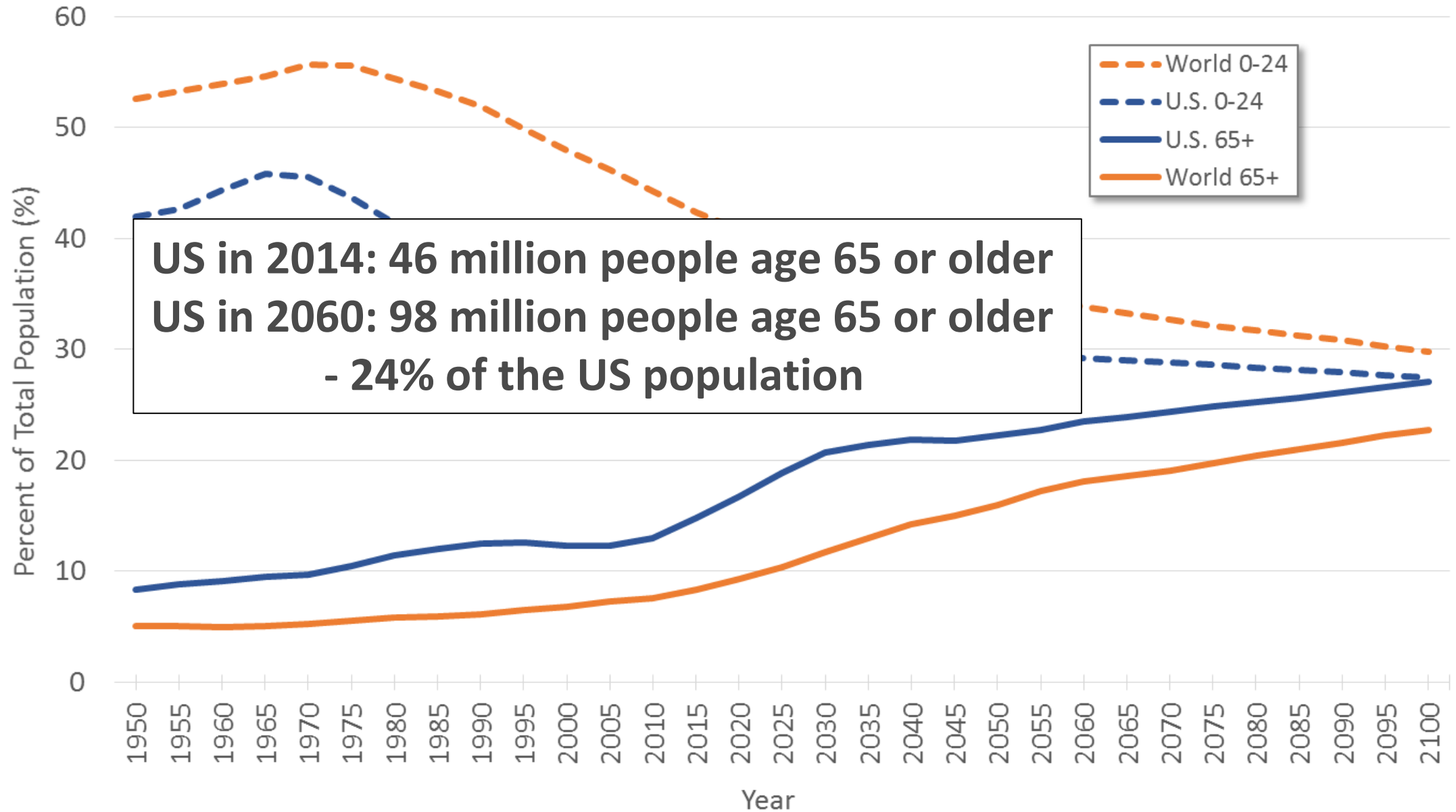
Virginia Tech Transportation Institute

Gena Glickman, Ph.D.

UC San Diego Center for Circadian Biology



0-24 and 65+ as a Percent of the Global and US Population



US in 2014: 46 million people age 65 or older
US in 2060: 98 million people age 65 or older
- 24% of the US population

Sleep stats you probably didn't know...

1 Number of mammal species (humans) that voluntarily delay sleep

37% Percentage of Americans that have admitted to falling asleep at the wheel

70,000,000
Number of Americans who have some form of sleep disorder

1.9
Average number of hours a giraffe sleeps in a day

7-10
The maximum number of consecutive days doctors recommend using OTC sleep aids.

1,055 Number of hours of sleep a new parent loses in just the first years of a child's life

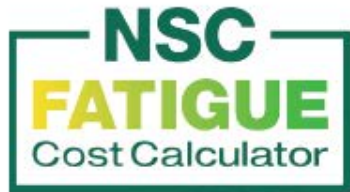
25%
Percentage of married couples who report sleeping in separate beds

\$100,000,000,000
Annual cost to Americans from lost productivity, medical expenses, sick leave, and property damage caused by sleep deprivation



CALCULATING

the Cost of Poor Sleep ~ Methodology



Diminished alertness is often caused by sleep deficiency and undiagnosed and untreated sleep disorders. This results in substantial direct and indirect costs due to:

- Absenteeism (missed hours of work)
- Presenteeism (diminished actual work performance relative to potential performance)
- Health care expenditures for illness and treatment of associated health conditions
- Workplace accidents and occupational injuries
- Commute-related motor vehicle crashes

BRIGHAM HEALTH



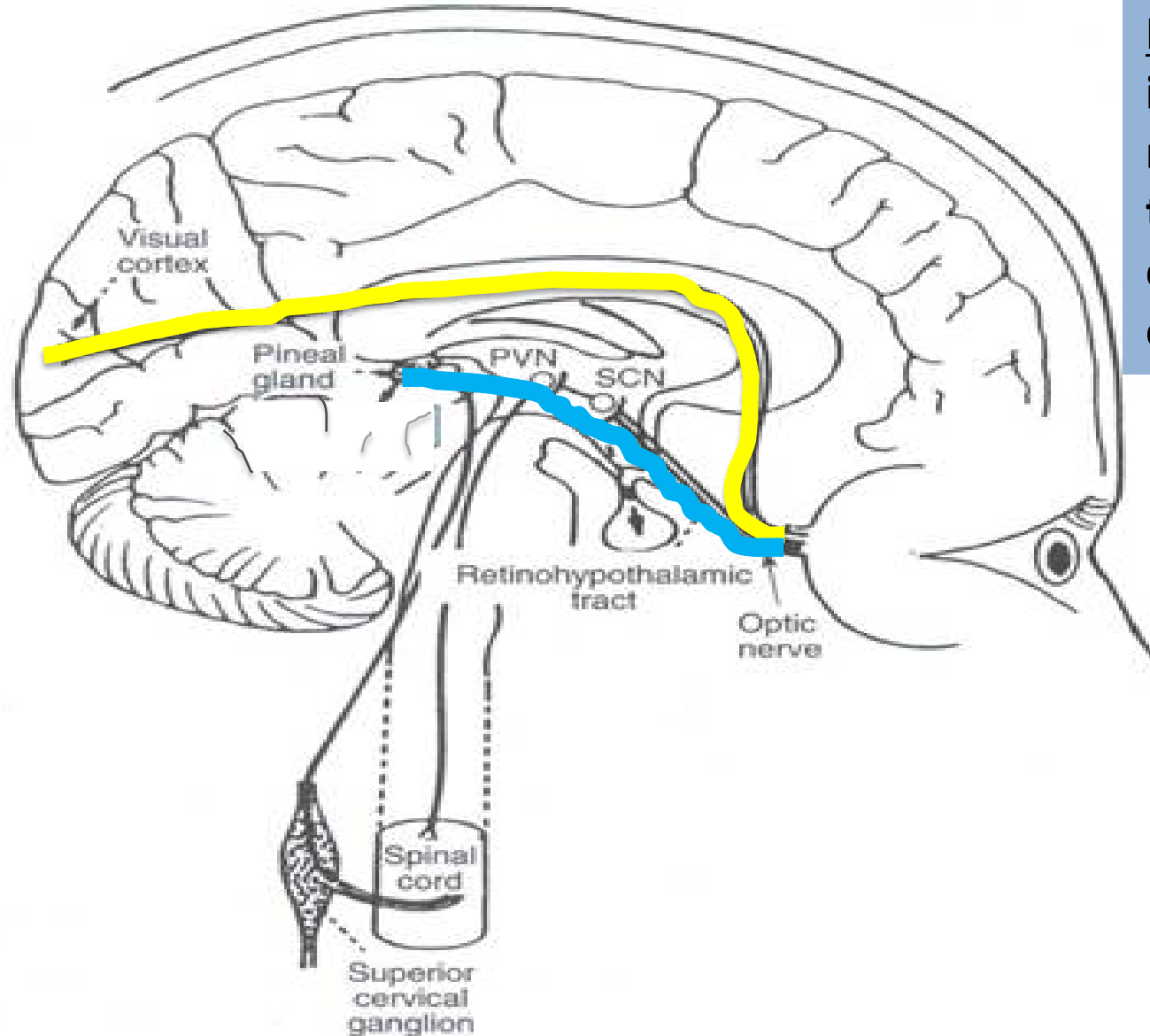
BRIGHAM AND WOMEN'S
Sleep Matters Initiative

Physiological effects of light

Visual Pathway

Retinal Ganglion Cells (RGCs) carry signals from the rods and cones to the visual cortex, which controls vision

- *Writing*
- *Reading*
- *Watching*
- *Communicating*
- *Learning*
- *Focusing*
- *Appreciating*
- *Enjoying*



Non-Visual Pathway

ipRGCs are photoreceptors connected to the hypothalamus, which controls many biological effects

- *Suppressing melatonin*
- *Enhancing alertness*
- *Affecting cognition*

- *Photic*
- *Non-photic*

Tunable LED Systems

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

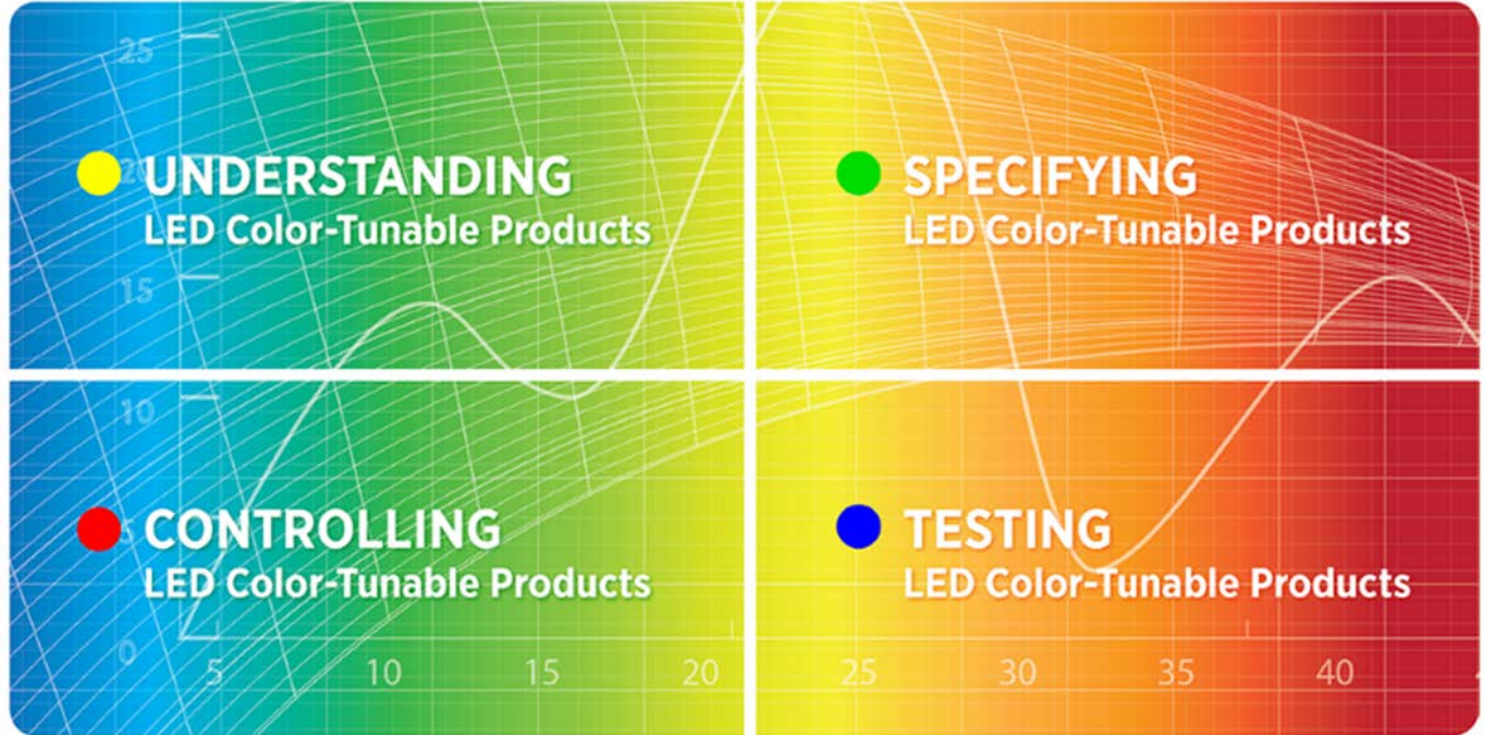
CALiPER

Report 23:
Photometric Testing of White-Tunable LED Luminaires

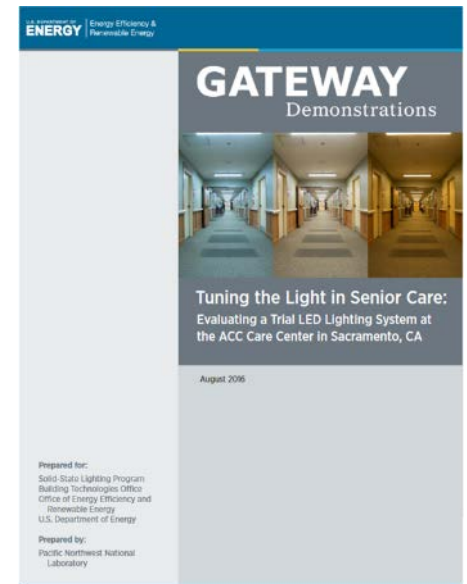
August 2015
Addendum January 2016

Prepared for:
Solid-State Lighting Program
Building Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Prepared by:
Pacific Northwest National Laboratory



ACC Care Center – Senior Care



Corridor tunable lighting system

- Automatic time-based script w/ override
 - 7 AM – 2 PM: 6500 K at 66% output
 - 2 PM – 6 PM: 4000 K at 66% output
 - 6 PM – 7 AM: 2700 K at 20% output
- Goal: min melatonin suppression in PM (warm, dim)
- Goal: max melatonin suppression in AM (cool, bright)
- Amber night light systems

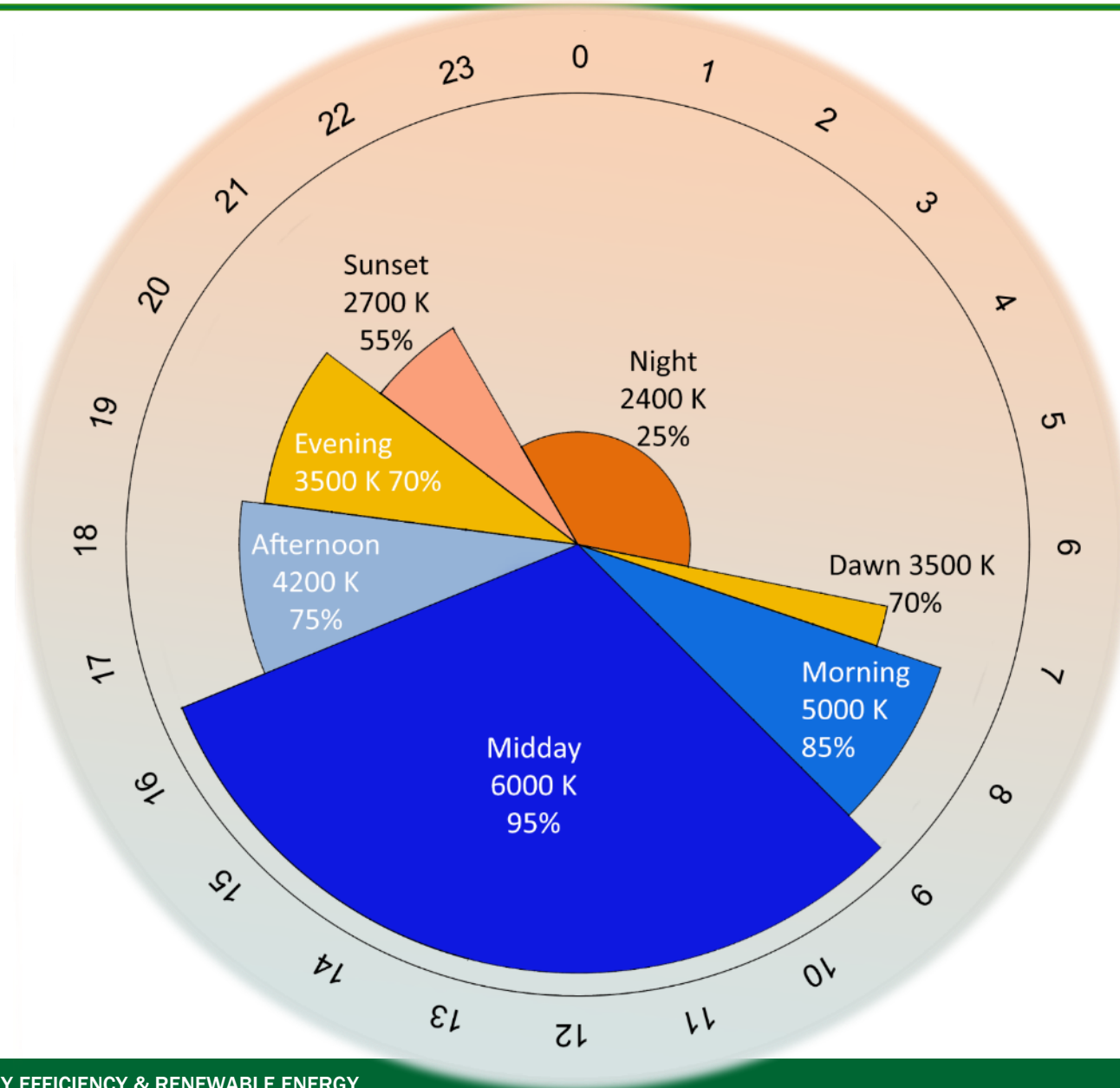


Dining room / lounge tunable lighting system

- Automatic time-based script w/ dimming override
- Goal of supporting biophilic design and healthy circadian functioning
- Tunable downlights and coves



Swedish Medical Behavioral Health Unit



Carrollton-Farmers Branch Schools



4200K

3000K

3500K

5000K



1: FULL - All 100%

2: AV - Front Off,
Room 40%

3: PRESENT - Front
100%, Room 60%

4: ALL Dim 10%

UP / DOWN -
Change all by 5%
each click





Photos: Acuity Brands Lighting

Energy implications?

- **ACC Care Center**
 - Corridors versus existing: 68% savings
 - Savings could be more if designer knew how much light for how long in AM
- **Swedish Medical BHU**
 - Versus high light level (“circadian”) non-tunable base case: 41% savings
 - Versus recommended light level non-tunable base case: 18% increase
 - 6 hours of circadian stimulating light accounted for 74% of lighting energy
 - Does it need to be THAT much light for THAT long?
 - Does it need to all be provided by the electric lighting system?

Human response measures?

- **ACC Care Center**
 - Facility staff tracked behaviors (agitation, falls, etc.) and medications; showed before and after differences
 - No documentation of physiological responses
 - Limited trial: three individuals, one corridor
- **Swedish Medical BHU**
 - No human response measures; no data on “before” system
- **CFB Schools**
 - Interviews with teachers
 - No student outcome measures

The Nobel Prize in Physiology or Medicine 2017



Mechanisms for Biological Clocks

Nobelforsamlingen
The Nobel Assembly at Karolinska Institutet

copyright: © The Nobel Committee for Physiology or Medicine, illustrator: Mattias Karlén



The Nobel Prize
@NobelPrize

Follow

The 2017 #NobelPrize #Medicine "for their discoveries of molecular mechanisms controlling the circadian rhythm"

2:34 AM - Oct 2, 2017 · Stockholm, Sweden

10 2,160 1,641

NATURE | NEWS

عربي

Nobel for blue LED that revolutionized lighting

Physics prize recognizes potential of invention with power to reduce global electricity consumption.

Elizabeth Gibney

07 October 2014



PDF



Rights & Permissions