

BOARD OF SELECTMEN

Tuesday, October 25th, 2016

Minutes

The Board of Selectmen met on Tuesday, October 25, 2016 at 7:00 p.m. at the Town Hall (Clark Room). Those present were Acting Chair Luke Ascolillo, William Risso, Claude von Roesgen, Kerry Kissinger (attending by remote participation) and Town Administrator Timothy Goddard.

Not present was Nathan Brown.

Community Input:

Lyn Lemaire (West St.) explained that she has returned to talk more about the Open Meeting Law (OML) requirements and the transparency of items being discussed in open meetings. She suggested that the Board of Selectmen agendas include more detail about the actual items being discussed such as previous action items and goals. She also requested that all documents being reviewed and discussed be made available to the public.

Approve Municipal Facilities Committee charge

Luke Ascolillo noted that the comments from the School Committee have not been received.

Town Administrator Tim Goddard explained that the Finance Committee has reviewed the Municipal Facilities Committee draft charge and have recommended that the committee work in concert with the Long Term Capital Requirements Committee (LTCRC) and change the word “approve” to “recommend” in the 1st sentence of the third paragraph... “The Finance Committee will also approve all Facility Projects that will be submitted to the long term capital committee for funding requests.”

Town Administrator Tim Goddard explained that the Town of Carlisle passed a bylaw in 1972 establishing a Town Building Committee. This committee was established by vote under Article 2 of the warrant for the special town meeting held April 9, 1962, and further amended under Article 9 of the warrant for the special town meeting held June 29, 1972. The Building Committee shall have general supervision over the design, construction and renovation of public buildings.

William Risso explained that the intent of the Municipal Facilities Committee was to help out the Library and other town owned facilities to keep up with necessary building repairs by creating 10-year capital improvement plans for each building. His biggest concern is that the Municipal Facilities Committee would involve oversight by the Board of Selectmen and the bylaw committee does not. Important repairs may be pushed back or overlooked and become even more expensive.

Town Administrator Tim Goddard confirmed that the bylaw committee is not active and there are no appointed members. He suggested that the board continue to develop a charge for the Municipal Facilities Committee and work towards amending the bylaw for the Town Building Committee at the spring Town Meeting.

Lyn Lemaire (West St.) suggested that the committee charge include regular scheduled meetings, informative agendas, advertise hearings with public input welcomed and relevant documents be made available to the public along with the meeting minutes to avoid having disputes similar to the Minuteman School Building Project.

Approve Deer Committee charge

Luke Ascolillo explained that based upon comments received from the Carlisle Conservation Committee the charge was amended to include "land trusts and agencies such as the U.S. Fish and Wildlife Services which currently allows hunting on the refuge."

Lyn Lemaire (West St.) and Dave Smith (Rutland St.) expressed their concerns about the formation of this committee and its charge. She handed out excerpts of MGL ch.53 Section 18A and Section 18B and explained that her concern is that the ballot question at the 2015 Town Meeting was a nonbinding public opinion advisory question whereas the requirements under ch.53 Section 18B would have required full text of the question along with a summary statement describing the effect of a yes or no vote and arguments for and against the question. She is concerned that there should have been two questions asked. 1st question should have been ... "Shall the Town of Carlisle allow hunting on Town owned lands?" and the 2nd question "Shall the Town of Carlisle request the Selectmen to place an article on the next Town Meeting Warrant to regulate bow hunting on Town owned lands as an approach to deer management?"

Davis Smith stated that residents who were opposed to hunting did not have an opportunity to express their concerns. There was a brochure handed out at the 2015 Town Meeting which he feels was pro hunting. He is concerned that the Board of Selectmen is taking the 2015 ballot question as the final vote on the issue of allowing hunting on Town owned property by establishing this committee.

Lyn Lemaire strongly urged the Board of Selectmen to postpone establishing this committee until a town-wide discussion has been held and the question to allow hunting on town owned property has been asked.

Selectmen Ascolillo and Risso explained that the purpose of the Deer Committee would be to hold these types of discussions to include: To allow hunting allowed on Town owned property; determine which parcels of land would be open to hunting; location restrictions within the parcels of land with respect to borders, trails, natural features; qualifications of hunters; permitting process; permitting fees; authority of the Conservation Commission; and the need for a game warden or another enforcement official; and any other aspects related to deer hunting that might be discovered during the process of investigating these matters.

William Risso pointed out that the Conservation Commission also raised a serious issue about protecting vegetation at risk due to the deer population during the 2015 Board of Health public forum discussion about creating a committee to review the pros and cons of allowing hunting which resulted in a non-binding ballot question at the 2015 Town Meeting. Mr. Risso stated that stopping the conversation after a ballot question passed would be wrong.

Luke Ascolillo pointed out that State officials are allowing hunting on State parks.

Lyn Lemaire requested that the Board of Selectmen also appoint someone that is opposed to hunting to the committee to balance out the bias. She also requested that the selectmen add a section under the purpose of committee to determine whether or not hunting should be allowed on Town property and a require regular scheduled meetings and reasonable notice of posted agendas along with comprehensive minutes posted to the Town website so that residents can be kept informed.

Mr. Kissinger commented that it is a good time to start the conversation and hold these types of discussions in order to get a leg up since State officials are already allowing hunting on State Park property as a way to reduce the deer herd.

On the motion made by William Rizzo and seconded by Claude von Roesgen it was VOTED to approve the Deer Committee charge as *presented* on October 25, 2016. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Rizzo-Aye and K. Kissinger-Aye.*

DOG Control Subcommittee

Purpose: To evaluate the need for action concerning dog related issues. The Subcommittee will evaluate whether the Town should amend its current bylaws, adopt new bylaws, or take no action. The main areas to be evaluated are

- 1) Public Safety – the Town of Carlisle does not currently have a leash law and this should be evaluated. Information on incidents should be collected through open meetings with the public as well as statistics collected from Carlisle Police Department, Board of Health, Conservation Commission and the Dog Officers. Thorough evaluation of leash laws in surrounding towns should be evaluated and their impacts should be determined.
- 2) Animal Waste – The Town of Carlisle currently has a bylaw pertaining to the non-removal of animal waste from private property; it does not necessarily pertain to Town owned land. The Committee should determine if this bylaw is adequate and if it is truly enforceable and the need for a bylaw on Town owned land as well.
- 3) Dog Licensing – Based on numbers from the Clerk’s Office there are a significant number of unregistered/unlicensed dogs in Carlisle. The committee should investigate registration requirements and determine possible enforcement actions for owners who do not register their animals.
- 4) Prolonged Barking - The Town of Carlisle currently has a bylaw pertaining to prolonged barking. Is the current bylaw adequate and enforceable? Review the number of registered complaints and consult with the Dog Officer regarding effectiveness.
- 5) Authority of Dog Officer – Evaluate the current authority the dog officer has and determine if it is adequate or should, and can be, expanded to include enforcement.

The subcommittee should include 2 members from the community, one dog owner and one non-dog owner. The subcommittee will also include one member designated to represent the Board of Selectmen, one member designated to represent the Board of Health, one member designated to represent the Recreation, one member designated to represent the Conservation Commission, one of the Town Dog Officers and a member of the Police Department.

If the Subcommittee determines that it would be in the best interests of the Town to adopt bylaw changes, the Subcommittee will be responsible for drafting a proposed bylaw or bylaw change to address the issue. The Subcommittee should also consider whether the bylaw changes should apply to all Town owned land or if certain Town parcels should be excluded. Town owned land includes public ways as well as parcels of land subject to the jurisdiction of the Board of Selectmen, Conservation Commission, School, Recreation, and land governed by other Town departments.

Luke Ascolillo updated the board on the designated members from other town boards/committee to include:

- Todd Brady – Board of Health
- Dan Wells – Conservation Commission
- Drew McMorrow – Recreation Committee
- Lt. Leo Crowe – Police Department
- Luke Ascolillo – Board of Selectmen

Remaining positions to be filled include:

- Dog Officer Appointment (email sent Matt Svatek to confirm his availability)
- Two (2) members from the community, one dog owner and one non-dog owner.

The Board agreed to invite the three applicants interested in serving on the committee to attend the Nov. 9th Board of Selectmen Meeting.

BOS Liaisons

On the motion of William Risso and seconded by Claude von Roesgen, it was VOTED to approve the FY2017 Liaisons for the Board of Selectmen as presented on October 25, 2017. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

Department

Audit Committee
Board of Appeals
Board of Assessors
Board of Health
Building Inspection Services
Carlisle Public School
CCHS
Minuteman High School
CCTV
Community Preservation Act Committee
Communications Center
Conservation Commission
Council on Aging
Department of Public Works
Energy Task Force Committee
Finance Committee
Finance Director
Financial Management Team
Fire Department
Historical Commission
Housing Authority
Library
Long Term Capital Requirements Committee
Pathways Committee II
Personnel Board
Planning Board
Police Department
Recreation Commission
Technology
Town Accountant
Town Clerk
Veterans Committee
Dog Committee
Bow Hunting Committee
Municipal Facilities Committee

Liaisons

Bill and Luke
Bill
Bill and Luke
Bill
Bill and Nathan
Bill and Luke
Kerry
Kerry
Kerry
Luke
Nathan
Luke
Kerry
Nathan
Claude and Bill
Bill and Luke
Bill and Luke
Bill and Luke
Bill and Nathan
Nathan
Claude
Kerry and Bill
Kerry and Bill
Claude
Kerry and Nathan
Claude and Nathan
Luke and Nathan
Luke
Nathan and Bill
Bill and Luke
Nathan
Claude
Luke
Kerry
Bill

Agriculture Commission	Claude
Center Park Standing Committee	Kerry
Conservation Restriction Advisory Committee	Claude
Land Stewardship Committee	Claude
Scholarship Advisory Committee	Kerry and Claude
Senior Tax Advisory Committee	Kerry

Streetlights Discussion

The Board received a copy of the updated LED Streetlight Project Report. The Energy Task Force (ETF) received 24 written responses to the article published in the Mosquito newspaper requesting feedback for residents about the recommendation to reduce the number of existing streetlights. The newspaper article also contained a link to the online map showing which light poles would remain and which ones would be turned off.

Jim Getty (Oak Knoll Rd.) submitted several documents concerning streetlights entitled "Adverse Health Effects of Nighttime Lighting" and "New American Medical Association statement on street lighting: the current "white" LEDs are too bright for optimum safety and health", AMA's new policy statement on street lighting, "Health Effects Light at Night", "Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting", and General Electric's white paper: "Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting."

Mr. Getty's cautioned the Board of Selectmen on its decision regarding color, brightness and installation/shielding of lights to avoid adverse health and environmental effects from the new LED street lighting systems.

Claude von Roesgen explained that the Energy Task Force (ETF) consulted Dr. Alan Lewin of Carlisle who is an expert on the matter. His many qualifications include being a member of Illuminating Engineering Society of North America (IESNA) and the American Academy of Optometry. Dr. Lewis reviewed the lamp specification to ensure that the light from the lamp only illuminates the road. He also met with the Safety Committee to advise them of exactly what will be installed.

William Risso pointed out that the Board of Selectmen will need to take a vote to reduce the number of LED Streetlight Replacements and approve the scope options (fixed vs. dimmable settings).

Claude von Roesgen requested that the job description for Green Communities Grant Administrator position be reviewed to see how many hours can be absorbed by the Town Administrator/Town staff.

This agenda item will be continued to a future meeting pending further updates.

Action Items from previous meetings

The Board reviewed the updated list of action items from previous meetings as follows:

1. **Review Town Bylaw & Building Regulations** - Notification to abutters/30-day comment period for building permits and review current zoning for the allowed size of a secondary building on two-acre parcel.
 - New software will allow permit to be posted on-line as they are approved by Building Inspector
 - Sent request to the Planning Board. 10/4/16 – No update

2. **Delinquent Tax Payers** – Withhold approval of licenses and permits.
 - Scheduled for 11/09/16 BOS Meeting
3. **LED Streetlights** –
 - Board of Selectmen vote to reduce the number of LED Streetlight replacements and approve scope options
4. **LED Crosswalk Signals**
 - Police Chief researching options on low profile fixtures at the request of the Historical Commission.
5. **Comcast** – request for town-wide coverage
 - Still attempting to schedule meeting in with Comcast Representatives
6. **Greenough Barn Property**
 - Final report to be made public soon w/disclaimer that alternatives presented may not be feasible
7. **Deer Task Force Committee Charge** – approved charge on 10/25/16.
8. **Municipal Aggregation Plan** - Submitted to the DPU. No update.
9. **Personnel Board** – Reduce membership from 5 to 3 members not including the 2 citizen- at-large positions.
 - Personnel Board to discuss on 11/10/16
10. **BOS** – Upload meeting packet material to website after each Board of Selectmen meeting.

Town Administrator's Report

1. **TILL Open House on November 3rd** - Open House for the TILL Group Home located at 338 Bedford Road on Thursday, November 3rd from 4:00pm – 6:00pm have been mailed to all Town officials.
2. **Procurement Policy Revisions** - Due to the recent passage of the Municipal Modernization Act, the procurement threshold for Goods and Services have been amended. The Board received a revised copy of the Town's procurement policy to reflect the new limits.

On the motion made by William Risso and seconded by Claude von Roesgen, it was VOTED to amend the Town of Carlisle Policy on Procurement of Supplies and Services as presented on October 25, 2016 to bring the policy into compliance with the Municipal Modernization Act. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

3. **MAPC Appointment** - Selectman William Risso volunteered to serve as the Town's representative to the Metropolitan Area Planning Council (MAPC), the regional planning commission for the Boston Metro Area.

On the motion made by Claude von Roesgen and seconded by William Risso it was VOTED to appoint William Risso as Carlisle's representative on the Metropolitan Area Planning Council for a term to expire on June 30, 2017. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

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4. **Community Preservation Committee Appointments** - The terms on the Community Preservation Committee are for three year. The designees from the Conservation Commission, Historical Commission and Planning Board need to be reappointed

On the motion made by William Risso and seconded by Claude von Roesgen, it was VOTED to re-appoint Angie Verge, Annette Lee and Ed Rolfe to three year terms on the Community Preservation Committee to expire on June 30, 2019. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

5. **Conservation Commission** - The Conservation Commission has requested that the Board of Selectmen approve the use of the Wetlands Protection Aid, "Intent's" account for the purpose of funding 80 additional hours during FY17 for the Conservation Administrative Assistant. Funds in this account accrue from the filing fees paid by applicants to the Conservation Commission under the Massachusetts Wetland Protection Act. The Personnel Board approved this last Thursday and the Board has routinely approved the use of these funds for this purpose this past June. A suggested motion follows.

On the motion made by William Risso and seconded by Claude von Roesgen, it was VOTED to approve the use of the Wetlands Protection Aid, "Intent's" account for the purpose of funding 80 additional hours at a cost not to exceed \$2,000.00 for the Conservation Commission administrative assistant. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

Upcoming Meeting Schedule:

Wednesday, November 9, 2016

- FY16 Audit Report
- FY17 Tax Classification hearing
- Policy re: delinquent taxpayers
- Finalize BoS FY17 Goals
- Dog & Deer Committee Appointments

Tuesday, November 22, 2016

- License Renewals
- Town Counsel – Presentation on Open Meeting Law and the New Public Records Act
- CETF Update on Streetlighting Project

Appointments/Resignations:

Agricultural Commission - On the motion made by William Risso and seconded by Claude von Roesgen, it was VOTED to accept with gratitude and appreciation the resignation of Judy Asarkof from Agricultural Commission. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

Liaison Reports

Claude von Roesgen-

1. Solar committee finalized the bylaw and they are scheduled to meet with the Planning Board for a preliminary review.

2. Claude von Roesgen requested a formal vote to direct DPW Superintendent to log vehicle fuel consumption as discussed at the last meeting.

On the motion of Claude von Roesgen and seconded by William Risso, it was VOTED to direct DPW Superintendent Gary Davis record all vehicles that are replenished with fuel log the vehicle mileage and identification of vehicle. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

William Risso – 10/25/16 Financial Management Team meeting highlights:

- Department of Revenue approved the FY17 property values for the Town of Carlisle.
- New growth expected to be lower next year
- Real Estate Tax Bills due next week
- 12-15% increase expected for employee health insurance
- Health plan coverage changes to be revisited next year.
- 2.4M Free Cash Certification

Luke Ascolillo

1. Cranberry Bog Update – Final report to become public with a disclaimer to explain that the alternatives presented may not be feasible.
2. CPC Plan Public Hearing will be published in the Mosquito

Kerry Kissinger -

1. Minuteman Regional High School – Kerry Kissinger stated the Town of Belmont will be voting whether not to stay in district. Currently 9 members in and 7 members out.
2. Center Park Committee looking for guidance and support with the responsibility of managing the park from a private citizen into a town committee. There are three members appointed on the committee.

Minutes Approval

On the motion made by William Risso and seconded by Claude von Roesgen, it was VOTED to approve the amended minutes of October 25, 2016. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

On the motion made by William Risso and seconded by Claude von Roesgen, it was VOTED to adjourn the meeting. *Roll Call Vote: Ascolillo-Aye, C. von Roesgen-Aye, W. Risso-Aye and K. Kissinger-Aye.*

9:35PM Adjourn.

Respectfully submitted by Jennifer Gibbons

Agenda Item: BOS Goals / Liaisons

- I Put *Actual* Item for Discussion on BOS Agenda

- II Advertise the Actual Goal
 - Documents, Arguments
 - Invite Public Input

- III Questionable “To-Dos” in 2015 “Goals”
 - “Support” Pathways
 - Enact LIP Regulations (Developers love this idea, gives up town’s leverage without corresponding benefit)
 - “Support” Full Time Police Department

- IV Goals Should Be Overarching (High Ground) and Specific, e.g:
 - Tax Increase <2%
 - Decide: 1.5% Land Area or 10% Units for 40B Obligation
 - Increase Participation in TM

M.G.L. ch.53, Section 18B ... (b) The governing body of a city, town or district which accepts this section in the manner provided in section 4 of chapter 4 shall print information relating to each question that shall appear on the city, town or district ballot. The information shall include: (1) the full text of each question; (2) a fair and concise summary of each question, including a 1 sentence statement describing the effect of a yes or no vote, which shall be prepared by the city solicitor, town counsel or counsel for the city, town or district; and (3) **arguments for and against each question** as provided in subsections (d) and (e). Not later than 7 days before an election at which the question shall be submitted to the voters in a city, town or district, *the information in this subsection shall be sent to each household* wherein a person whose name appears on the current voting list for the city, town or district resides.

... (d) Not later than 7 days after the determination that a question shall appear on the ballot, the city solicitor or town or district counsel, as applicable, *shall seek written arguments from the principal proponents and opponents of the question*. For the purposes of this section, the principal proponents and opponents of a question shall be those persons determined by the solicitor or counsel to be best able to present the arguments for and against the question. The solicitor or counsel shall provide not less than 7 days' written notice to the opponents and proponents of the date on which the written arguments shall be received. Proponents and opponents shall submit their arguments, which shall be not more than 150 words, to the solicitor or counsel, together with a copy thereof to the city or town clerk or, in a district, to the clerk of each city and town within the district. The arguments and summary shall be submitted by the solicitor or counsel to the governing body at least 20 days before the election for distribution to voters in accordance with subsection (b). A copy of the arguments and summary shall also be submitted by the solicitor or counsel to the city, town or district clerk.

(e) *In determining the principal proponents and opponents of a ballot question*, the solicitor or counsel shall contact each ballot question committee, if any, as defined in section 1 of chapter 55. The principal proponents or opponents of a ballot question may include officers of a ballot question committee or officers of a city, town or district office or committee including, but not limited to, a finance committee or a school committee. In addition, the principal proponents or opponents may include the first 10 signers or a majority of the first 10 signers of a petition initiating the placement of such question on the ballot. The solicitor or counsel shall determine, based on a review of arguments received, the person or group best able to present arguments for and against a question. If no argument is received by the solicitor or counsel within the time specified by the solicitor or counsel, the solicitor or counsel shall prepare an argument and submit the argument to the governing body and to the city or town clerk or, in a district, to the clerk of each city and town within the district within the time specified in subsection (d).

M.G.L. ch. 53, Section 18A ... A **nonbinding** public opinion advisory question may be placed on the ballot for a regular municipal election in any city or town no later than the thirty-fifth day preceding such election:... by vote of the board of selectmen of a town ...

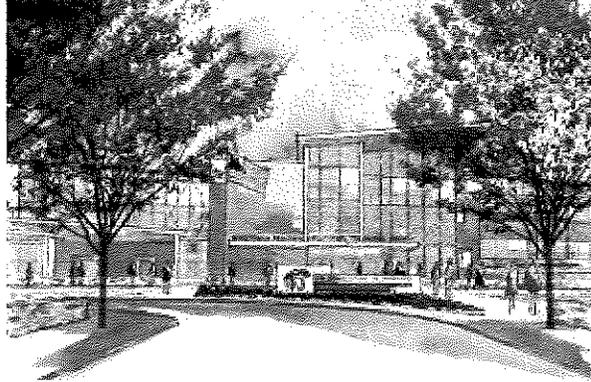
NON-BINDING BALLOT QUESTION

BOW HUNTING ON TOWN-OWNED LANDS

Question 3: Shall the Town of Carlisle request the Selectmen to place an article on the next Town Meeting warrant to regulate bow hunting on Town-owned lands as an approach to deer management?

YES _____ NO _____

AVOID THE PROBLEM OF A BIG, TOO EXPENSIVE PROJECT – 2x the cost of what may have been necessary



Main Entry Sketch, KBA

2015

Welcome to the Minuteman School Building Committee website!

1. Regularly Scheduled Meetings / Ample Notice
2. Informative Agendas
 - a. Hearings with Public Input Welcomed
 - b. Relevant Documents Available in Advance
3. Comprehensive and Timely Minutes
4. Larger Issues Advertised with Good Notice

Adverse Health Effects of Nighttime Lighting

The problems associated with light pollution, such as energy waste, sky glow, and environmental impact are now becoming well known. But less well known is the burgeoning growth of research that demonstrates direct human-health issues related to excess light. Though we certainly need to be mindful of wasting energy, health effects might ultimately be the most important reason to control light pollution. The energy wasted by excessive lighting is produced primarily by burning fossil fuels, leading directly to air pollution that causes higher asthma rates and increased respiratory problems for people with lung disease and other medical issues.

Glare is the most common health safety problem resulting from poorly designed outdoor lighting. You have probably noticed poor vision stemming from glare on a dirty windshield. Over time, calcifications build up in the lenses of our eyes, which eventually develop into a cataract. These calcifications and other lens and eye imperfections scatter light in a similar fashion to a dirty windshield. This effect grows more severe with age, and is the primary reason why the elderly have a difficult time driving at night near poorly designed street lights. Most people with this problem are not even aware that it's the glare that's the main cause of their poor night vision, and that they would be able to drive more safely if street lights were properly designed. Recognizing that our streets could be safer places at night, the American Medical Association (AMA) adopted a resolution in 2009 urging full shielding for all public street lighting.

Ultimately, the most significant human effect of night lighting is on circadian-rhythm disruption. Numerous papers over the past 15 years have led medical researchers to conclude that night light increases the incidence of certain cancers, most notably breast cancer. In fact, researchers now estimate that a not insignificant fraction of breast cancers are secondary to light at night suppressing circadian rhythm. The research basis for this conclusion has become so compelling that the World Health Organization recently declared circadian-rhythm disruption as a class 2A carcinogen — placing it on the same level of severity as the effects of tobacco smoke on lung cancer.

The biochemical mechanism for this has been thoroughly researched and is thought to result from the suppression of melatonin production by the pineal gland in the center of our brain. This gland produces the hormone melatonin while we sleep. Repeated shift changes of night workers or repeated exposure to

night lighting in our bedrooms markedly suppresses melatonin production. Previous research has shown that this hormone helps the immune system suppress the development of several types of cancers. In 2012, the AMA adopted as policy, a monograph entitled: "Adverse Health Effects of Nighttime Lighting", summarizing an extensive world literature on this subject.

Mario Motta, MD, FACC

New American Medical Association statement on street lighting: the current “white” LEDs are too bright for optimum safety and health

The American Medical Association (AMA) has just adopted an official policy statement about street lighting: cool it and dim it. This is because the new LED street lighting that is sweeping the country is too harsh and bright for optimum safety and health. The statement was adopted unanimously by the AMA House of Delegates at its annual meeting in Chicago this week (1). It states that outdoor lighting at night, particularly street lighting, should have a color temperature of no greater than 3000K. Color temperature (CT) is a measure of the spectral content of light from a source (2); how much blue, green, yellow, and red there is in it. Higher CT generally means greater blue content, and the whiter the light appears.

A white LED at CT 4000K or 5000K contains a high level of short wavelength, blue light; this has been the choice for a number of cities that have recently retrofitted their street lighting such as Seattle (3) and New York (4). Complaints about the harshness of these lights in these cities are surging. An extreme example is the city of Davis, California where the residents demanded a complete replacement of these high CT street lights (5). An incandescent bulb at color temperature of 2,400K contains far less blue and far more yellow and red wavelengths. Before electric light, we burned wood and candles at night; this artificial light has a CT of about 1800K, quite yellow/red and almost no blue.

A color temperature wrinkle

Color Temperature reliably predicts spectral content of light (i.e., how much of each wavelength) from a true “black body radiator” which is approximated by the tungsten filament in an incandescent bulb. However, for other types of light sources such as fluorescent and LED, it does not so reliably do so. Another technical term is used for these sources called correlated color temperature (CCT). It adjusts the spectral content of the light source to the color sensitivity of human vision. So, even at the preferable 3000K CCT compared to 5000K CCT for street lighting, two such light sources could have fairly large differences in blue light content.

Color rendering is an important consideration for lighting designers for use inside buildings. The more light across the wavelength spectrum (from blue to red), the better objects will be faithfully rendered for their color; in other words, the closer the colors of the object will be to what they are in sunlight. However, for outdoor lighting at night, another important aspect is the amount of blue light; the less the better, both to reduce glare and to minimize affects of human circadian health.

The reason color temperature matters

The AMA policy statement is particularly timely because the new Atlas of world light pollution just appeared last week (6), and street lighting is an important component of light pollution. One of the considerations of lighting the night is its impact on human health. I have been writing about this for The Conversation for a while, and have described how lighting affects our normal circadian physiology (7), how this could lead to some serious health consequences (8), and most recently how lighting the night affects sleep (9)

Bright electric lighting can also adversely affect wildlife (10)

Two problems with LED street lighting

The new “white” LED street lighting that is rapidly being retrofitted to cities throughout the country, has two problems according to the AMA. The first is discomfort and glare. Because LED light is so concentrated, it can cause severe glare, resulting in pupillary constriction that defeats the purpose of lighting the night for safe driving or walking. You can sense this easily if you look directly into one of the control lights on your new washing machine or other appliance: it is very difficult to do because it hurts. Street lighting can have this same effect if its blue content is high and there is not appropriate shielding.

The other issue addressed by the AMA statement is the impact on human circadian rhythmicity.

Street lighting and human health

The AMA has made three recommendations in its new policy statement:

First, the AMA supports a “proper conversion to community based Light Emitting Diode (LED) lighting, which reduces energy consumption and decreases the use of fossil fuels.”

Second, the AMA “encourage[s] minimizing and controlling blue-rich environmental lighting by using the lowest emission of blue light possible to reduce glare.”

Third, the AMA “encourage[s] the use of 3000K or lower lighting for outdoor installations such as roadways. All LED lighting should be properly shielded to minimize glare and detrimental human and environmental effects, and consideration should be given to utilize the ability of LED lighting to be dimmed for off-peak time periods.”

There is almost never a completely satisfactory solution to a complex problem. We must have lighting at night, not only in our homes and businesses, but also outdoors on our streets. The need for energy efficiency is serious, but so too is minimizing human risk, both from glare and human circadian disruption, from bad lighting. LED technology can optimize both when properly designed (11).

1. <http://www.ama-assn.org/sub/meeting/>
2. <http://www.ies.org/lighting/science/color.cfm>
3. <http://crosscut.com/2013/03/streetlights-seattle-led/>
4. http://www.nytimes.com/2015/03/24/nyregion/new-led-streetlights-shine-too-brightly-for-some-in-brooklyn.html?_r=0
5. <http://volt.org/lessons-learned-davis-ca-led-streetlight-retrofit/>
6. <https://theconversation.com/new-atlas-shows-extent-of-light-pollution-what-does-it-mean-for-our-health-60836>
7. <https://theconversation.com/a-dark-night-is-good-for-your-health-39161>
8. <https://theconversation.com/the-mystery-of-breast-cancer-40036>
9. <https://theconversation.com/are-we-sleep-deprived-or-just-darkness-deprived-49412>
10. <http://www.sciencedirect.com/science/article/pii/S0169534715001603>
11. <http://www.edisontechcenter.org/LED.html>

Subject: Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting

Acknowledgement: The Council thanks George Brainard, PhD (Thomas Jefferson University); Richard Stevens, PhD (University Connecticut Health Center); and Mario Motta, MD (CSAPH, Tufts Medical School) for their contributions in preparing the initial draft of this report, and the commentary by Travis Longcore, PhD, on the ecological impact of nighttime electrical lighting.

1 INTRODUCTION

2

3 With the advent of highly efficient and bright light emitting diode (LED) lighting, strong economic
4 arguments exist to overhaul the street lighting of U.S. roadways.¹⁻³ Valid and compelling reasons
5 driving the conversion from conventional lighting include the inherent energy efficiency and longer
6 lamp life of LED lighting, leading to savings in energy use and reduced operating costs, including
7 taxes and maintenance, as well as lower air pollution burden from reduced reliance on fossil-based
8 carbon fuels.

9

10 Not all LED light is optimal, however, when used as street lighting. Improper design of the lighting
11 fixture can result in glare, creating a road hazard condition.^{4,5} LED lighting also is available in
12 various color correlated temperatures. Many early designs of white LED lighting generated a color
13 spectrum with excessive blue wavelength. This feature further contributes to disability glare, i.e.,
14 visual impairment due to stray light, as blue wavelengths are associated with more scattering in the
15 human eye, and sufficiently intense blue spectrum damages retinas.^{6,7} The excessive blue spectrum
16 also is environmentally disruptive for many nocturnal species. Accordingly, significant human and
17 environmental concerns are associated with short wavelength (blue) LED emission. Currently,
18 approximately 10% of existing U.S. street lighting has been converted to solid state LED
19 technology, with efforts underway to accelerate this conversion. The Council is undertaking this
20 report to assist in advising communities on selecting among LED lighting options in order to
21 minimize potentially harmful human health and environmental effects.

22

23 METHODS

24

25 English language reports published between 2005 and 2016 were selected from a search of the
26 PubMed and Google Scholar databases using the MeSH terms “light,” “lighting methods,”
27 “color,” “photoc stimulation,” and “adverse effects,” in combination with “circadian
28 rhythm/physiology/radiation effects,” “radiation dosage/effects,” “sleep/physiology,” “ecosystem,”
29 “environment,” and “environmental monitoring.” Additional searches using the text terms “LED”
30 and “community,” “street,” and “roadway lighting” were conducted. Additional information and
31 perspective were supplied by recognized experts in the field.

32

1 ADVANTGAGES AND DISADVANAGES OF LED STREET LIGHTS

2
3 The main reason for converting to LED street lighting is energy efficiency; LED lighting can
4 reduce energy consumption by up to 50% compared with conventional high pressure sodium (HPS)
5 lighting. LED lighting has no warm up requirement with a rapid "turn on and off" at full intensity.
6 In the event of a power outage, LED lights can turn on instantly when power is restored, as
7 opposed to sodium-based lighting requiring prolonged warm up periods. LED lighting also has the
8 inherent capability to be dimmed or tuned, so that during off peak usage times (e.g., 1 to 5 AM),
9 further energy savings can be achieved by reducing illumination levels. LED lighting also has a
10 much longer lifetime (15 to 20 years, or 50,000 hours), reducing maintenance costs by decreasing
11 the frequency of fixture or bulb replacement. That lifespan exceeds that of conventional HPS
12 lighting by 2-4 times. Also, LED lighting has no mercury or lead, and does not release any toxic
13 substances if damaged, unlike mercury or HPS lighting. The light output is very consistent across
14 cold or warm temperature gradients. LED lights also do not require any internal reflectors or glass
15 covers, allowing higher efficiency as well, if designed properly.^{8,9}

16
17 Despite the benefits of LED lighting, some potential disadvantages are apparent. The initial cost is
18 higher than conventional lighting; several years of energy savings may be required to recoup that
19 initial expense.¹⁰ The spectral characteristics of LED lighting also can be problematic. LED
20 lighting is inherently narrow bandwidth, with "white" being obtained by adding phosphor coating
21 layers to a high energy (such as blue) LED. These phosphor layers can wear with time leading to a
22 higher spectral response than was designed or intended. Manufacturers address this problem with
23 more resistant coatings, blocking filters, or use of lower color temperature LEDs. With proper
24 design, higher spectral responses can be minimized. LED lighting does not tend to abruptly "burn
25 out," rather it dims slowly over many years. An LED fixture generally needs to be replaced after it
26 has dimmed by 30% from initial specifications, usually after about 15 to 20 years.^{1,11}

27
28 Depending on the design, a large amount blue light is emitted from some LEDs that appear white
29 to the naked eye. The excess blue and green emissions from some LEDs lead to increased light
30 pollution, as these wavelengths scatter more within the eye and have detrimental environmental
31 and glare effects. LED's light emissions are characterized by their correlated color temperature
32 (CCT) index.^{12,13} The first generation of LED outdoor lighting and units that are still widely being
33 installed are "4000K" LED units. This nomenclature (Kelvin scale) reflects the equivalent color of
34 a heated metal object to that temperature. The LEDs are cool to the touch and the nomenclature has
35 nothing to do with the operating temperature of the LED itself. By comparison, the CCT associated
36 with daylight light levels is equivalent to 6500K, and high pressure sodium lighting (the current
37 standard) has a CCT of 2100K. Twenty-nine percent of the spectrum of 4000K LED lighting is
38 emitted as blue light, which the human eye perceives as a harsh white color. Due to the point-
39 source nature of LED lighting, studies have shown that this intense blue point source leads to
40 discomfort and disability glare.¹⁴

41
42 More recently engineered LED lighting is now available at 3000K or lower. At 3000K, the human
43 eye still perceives the light as "white," but it is slightly warmer in tone, and has about 21% of its
44 emission in the blue-appearing part of the spectrum. This emission is still very blue for the
45 nighttime environment, but is a significant improvement over the 4000K lighting because it
46 reduces discomfort and disability glare. Because of different coatings, the energy efficiency of
47 3000K lighting is only 3% less than 4000K, but the light is more pleasing to humans and has less
48 of an impact on wildlife.

49
50 *Glare*

51

1 Disability glare is defined by the Department of Transportation (DOT) as the following:
2

3 “Disability glare occurs when the introduction of stray light into the eye reduces the ability to
4 resolve spatial detail. It is an objective impairment in visual performance.”

5 Classic models of this type of glare attribute the deleterious effects to intraocular light scatter in the
6 eye. Scattering produces a veiling luminance over the retina, which effectively reduces the contrast
7 of stimulus images formed on the retina. The disabling effect of the veiling luminance has serious
8 implications for nighttime driving visibility.¹⁵
9

10 Although LED lighting is cost efficient and inherently directional, it paradoxically can lead to
11 worse glare than conventional lighting. This glare can be greatly minimized by proper lighting
12 design and engineering. Glare can be magnified by improper color temperature of the LED, such as
13 blue-rich LED lighting. LEDs are very intense point sources that cause vision discomfort when
14 viewed by the human eye, especially by older drivers. This effect is magnified by higher color
15 temperature LEDs, because blue light scatters more within the human eye, leading to increased
16 disability glare.¹⁶
17

18 In addition to disability glare and its impact on drivers, many residents are unhappy with bright
19 LED lights. In many localities where 4000K and higher lighting has been installed, community
20 complaints of glare and a “prison atmosphere” by the high intensity blue-rich lighting are common.
21 Residents in Seattle, WA have demanded shielding, complaining they need heavy drapes to be
22 comfortable in their own homes at night.¹⁷ Residents in Davis, CA demanded and succeeded in
23 getting a complete replacement of the originally installed 4000K LED lights with the 3000K
24 version throughout the town at great expense.¹⁸ In Cambridge, MA, 4000K lighting with dimming
25 controls was installed to mitigate the harsh blue-rich lighting late at night. Even in places with a
26 high level of ambient nighttime lighting, such as Queens in New York City, many complaints were
27 made about the harshness and glare from 4000K lighting.¹⁹ In contrast, 3000K lighting has been
28 much better received by citizens in general.
29

30 *Unshielded LED Lighting*

31

32 Unshielded LED lighting causes significant discomfort from glare. A French government report
33 published in 2013 stated that due to the point source nature of LED lighting, the luminance level of
34 unshielded LED lighting is sufficiently high to cause visual discomfort regardless of the position,
35 as long as it is in the field of vision. As the emission surfaces of LEDs are highly concentrated
36 point sources, the luminance of each individual source easily exceeds the level of visual
37 discomfort, in some cases by a factor of 1000.¹⁷
38

39 Discomfort and disability glare can decrease visual acuity, decreasing safety and creating a road
40 hazard. Various testing measures have been devised to determine and quantify the level of glare
41 and vision impairment by poorly designed LED lighting.²⁰ Lighting installations are typically
42 tested by measuring foot-candles per square meter on the ground. This is useful for determining the
43 efficiency and evenness of lighting installations. This method, however, does not take into account
44 the human biological response to the point source. It is well known that unshielded light sources
45 cause pupillary constriction, leading to worse nighttime vision between lighting fixtures and
46 causing a “veil of illuminance” beyond the lighting fixture. This leads to worse vision than if the
47 light never existed at all, defeating the purpose of the lighting fixture. Ideally LED lighting
48 installations should be tested in real life scenarios with effects on visual acuity evaluated in order to
49 ascertain the best designs for public safety.
50

1 *Proper Shielding*

2
3 With any LED lighting, proper attention should be paid to the design and engineering features.
4 LED lighting is inherently a bright point source and can cause eye fatigue and disability glare if it
5 is allowed to directly shine into human eyes from roadway lighting. This is mitigated by proper
6 design, shielding and installation ensuring that no light shines above 80 degrees from the
7 horizontal. Proper shielding also should be used to prevent light trespass into homes alongside the
8 road, a common cause of citizen complaints. Unlike current HPS street lighting, LEDs have the
9 ability to be controlled electronically and dimmed from a central location. Providing this additional
10 control increases the installation cost, but may be worthwhile because it increases long term energy
11 savings and minimizes detrimental human and environmental lighting effects. In environmentally
12 sensitive or rural areas where wildlife can be especially affected (e.g., near national parks or bio-
13 rich zones where nocturnal animals need such protection), strong consideration should be made for
14 lower emission LEDs (e.g., 3000K or lower lighting with effective shielding). Strong consideration
15 also should be given to the use of filters to block blue wavelengths (as used in Hawaii), or to the
16 use of inherent amber LEDs, such as those deployed in Quebec. Blue light scatters more widely
17 (the reason the daytime sky is “blue”), and unshielded blue-rich lighting that travels along the
18 horizontal plane increases glare and dramatically increases the nighttime sky glow caused by
19 excessive light pollution.

20 21 POTENTIAL HEALTH EFFECTS OF “WHITE” LED STREET LIGHTING

22
23 Much has been learned over the past decade about the potential adverse health effects of electric
24 light exposure, particularly at night.²¹⁻²⁵ The core concern is disruption of circadian rhythmicity.
25 With waning ambient light, and in the absence of electric lighting, humans begin the transition to
26 nighttime physiology at about dusk; melatonin blood concentrations rise, body temperature drops,
27 sleepiness grows, and hunger abates, along with several other responses.

28
29 A number of controlled laboratory studies have shown delays in the normal transition to nighttime
30 physiology from evening exposure to tablet computer screens, backlit e-readers, and room light
31 typical of residential settings.²⁶⁻²⁸ These effects are wavelength and intensity dependent,
32 implicating bright, short wavelength (blue) electric light sources as disrupting transition. These
33 effects are not seen with dimmer, longer wavelength light (as from wood fires or low wattage
34 incandescent bulbs). In human studies, a short-term detriment in sleep quality has been observed
35 after exposure to short wavelength light before bedtime. Although data are still emerging, some
36 evidence supports a long-term increase in the risk for cancer, diabetes, cardiovascular disease and
37 obesity from chronic sleep disruption or shiftwork and associated with exposure to brighter light
38 sources in the evening or night.^{25,29}

39
40 Electric lights differ in terms of their circadian impact.³⁰ Understanding the neuroscience of
41 circadian light perception can help optimize the design of electric lighting to minimize circadian
42 disruption and improve visual effectiveness. White LED streetlights are currently being marketed
43 to cities and towns throughout the country in the name of energy efficiency and long term cost
44 savings, but such lights have a spectrum containing a strong spike at the wavelength that most
45 effectively suppresses melatonin during the night. It is estimated that a “white” LED lamp is at
46 least 5 times more powerful in influencing circadian physiology than a high pressure sodium light
47 based on melatonin suppression.³¹ Recent large surveys found that brighter residential nighttime
48 lighting is associated with reduced sleep time, dissatisfaction with sleep quality, nighttime
49 awakenings, excessive sleepiness, impaired daytime functioning, and obesity.^{29,32} Thus, white LED
50 street lighting patterns also could contribute to the risk of chronic disease in the populations of
51 cities in which they have been installed. Measurements at street level from white LED street lamps

- 1 are needed to more accurately assess the potential circadian impact of evening/nighttime exposure
- 2 to these lights.

1 ENVIRONMENTAL EFFECTS OF LED LIGHTING

2
3 The detrimental effects of inefficient lighting are not limited to humans; 60% of animals are
4 nocturnal and are potentially adversely affected by exposure to nighttime electrical lighting. Many
5 birds navigate by the moon and star reflections at night; excessive nighttime lighting can lead to
6 reflections on glass high rise towers and other objects, leading to confusion, collisions and death.³³
7 Many insects need a dark environment to procreate, the most obvious example being lightning bugs
8 that cannot “see” each other when light pollution is pronounced. Other environmentally beneficial
9 insects are attracted to blue-rich lighting, circling under them until they are exhausted and die.^{34,35}
10 Unshielded lighting on beach areas has led to a massive drop in turtle populations as hatchlings are
11 disoriented by electrical light and sky glow, preventing them from reaching the water safely.³⁵⁻³⁷
12 Excessive outdoor lighting diverts the hatchlings inland to their demise. Even bridge lighting that is
13 “too blue” has been shown to inhibit upstream migration of certain fish species such as salmon
14 returning to spawn. One such overly lit bridge in Washington State now is shut off during salmon
15 spawning season.

16
17 Recognizing the detrimental effects of light pollution on nocturnal species, U.S. national parks
18 have adopted best lighting practices and now require minimal and shielded lighting. Light pollution
19 along the borders of national parks leads to detrimental effects on the local bio-environment. For
20 example, the glow of Miami, FL extends throughout the Everglades National Park. Proper
21 shielding and proper color temperature of the lighting installations can greatly minimize these types
22 of harmful effects on our environment.

23
24 CONCLUSION

25
26 Current AMA Policy supports efforts to reduce light pollution. Specific to street lighting, Policy H-
27 135.932 supports the implementation of technologies to reduce glare from roadway lighting. Thus,
28 the Council recommends that communities considering conversion to energy efficient LED street
29 lighting use lower CCT lights that will minimize potential health and environmental effects. The
30 Council previously reviewed the adverse health effects of nighttime lighting, and concluded that
31 pervasive use of nighttime lighting disrupts various biological processes, creating potentially
32 harmful health effects related to disability glare and sleep disturbance.²⁵

33
34 RECOMMENDATIONS

35
36 The Council on Science and Public Health recommends that the following statements be adopted,
37 and the remainder of the report filed.

- 38
39 1. That our American Medical Association (AMA) support the proper conversion to
40 community-based Light Emitting Diode (LED) lighting, which reduces energy
41 consumption and decreases the use of fossil fuels. (New HOD Policy)
42
43 2. That our AMA encourage minimizing and controlling blue-rich environmental lighting by
44 using the lowest emission of blue light possible to reduce glare. (New HOD Policy)
45
46 3. That our AMA encourage the use of 3000K or lower lighting for outdoor installations such
47 as roadways. All LED lighting should be properly shielded to minimize glare and
48 detrimental human and environmental effects, and consideration should be given to utilize
49 the ability of LED lighting to be dimmed for off-peak time periods. (New HOD Policy)

Fiscal Note: Less than \$500

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DECEMBER 2014

GE LIGHTING LIGHTING AND SLEEP



INTRODUCTION

The National Institute of Health defines “circadian rhythms” as “physical, mental and behavioral changes that follow a roughly 24-hour cycle, responding primarily to light and darkness in an organism’s environment.”¹ Although, in the strictest sense, circadian rhythms refer to cyclical changes in hormones, body temperature, and other biological processes over the course of a 24 hour period, the term commonly is used to refer to the body’s natural sleep-wake cycle. Indeed, a disruption of a person’s circadian rhythms typically results in a disruption of the individual’s sleep-wake cycle.

The Department of Health and Human Services has reported that “sleep deficiency and circadian disruption resulting from lifestyle factors are increasingly common societal problems that increase disease risk through complex pathways.”² An estimated 50–70 million adults in the United States suffer from chronic sleep or wakefulness issues, and the percentage of adults who report averaging less than seven hours of sleep per night has increased by about one third since the 1980s.³ According to the National Institute of Health, sleep disorders have been linked to a growing list of long-term health problems, including a greater risk of heart disease, stroke, diabetes, obesity, and other diseases.”⁴

Lifestyle factors and stress levels certainly influence sleeping patterns, but more and more attention is being paid to the impact of light on sleep cycles. The invention of electric light in the nineteenth century and, more recently, the explosive rise of “screen time” associated with smart phones and tablets, places us in a world where we can have as much light as we want whenever we want it. Light, and human activity, is no longer tied to the rising and setting sun. But our biology is still linked to that astronomical cycle.

Recent scientific studies provide empirical and epidemiological evidence of positive and negative effects of lighting on sleep patterns. Light has the potential to strengthen our natural internal clocks but, more frequently, acts to disrupt it. Lighting solutions that more closely simulate the daily rhythms we receive from natural light may help improve our ability to enjoy sound sleep and awaken efficiently.

- 1 National Institute of Health, *Circadian Rhythms Fact Sheet*, http://www.nigms.nih.gov/Education/Pages/Factsheet_CircadianRhythms.aspx.
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EXECUTIVE SUMMARY

At the AMA House of Delegates 2012 Annual Meeting, the American Medical Association (AMA), the largest physician organization in the U.S., voted to adopt policy that recognizes “that exposure to excessive light at night, including extended use of various electronic media, can disrupt sleep or exacerbate sleep disorders, especially in children and adolescents.”⁵

At the center of this discussion is the impact of electric lighting, as well as the impact of modern electronics such as computer screens, phones, and tablets. These lighting and communication devices produce high levels of blue light, and this bluish light tends to suppress the body’s production of melatonin — the “sleep hormone.” Melatonin levels follow a daily rhythm, tending to drop sharply in the morning as we wake and then rising again in the evening, leading to end of the day drowsiness that fosters sleep.⁶

The link between light and melatonin production is well accepted in the scientific community. Many people would benefit from a more regular daily rhythm of light that mimics the intensity and spectrum that humans had received from natural lighting in the past. As discussed in more detail below, recent developments support this conclusion:

1. Studies going back several decades have established the link between melatonin and circadian/sleep rhythms. Recent scientific and medical studies are providing empirical and epidemiological evidence of the potential positive and negative effects of lighting on sleep.
2. Better scientific understanding of human circadian physiology has increasingly revealed the quantity, quality, and timing of light that is best for maintaining natural sleep-awake cycles.
3. Advancements in lighting technology now allow for precise spectral tailoring with LED technology.

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THE ROLE OF SLEEP ON WELLNESS

There is ample evidence supporting the benefits of regular and adequate sleep. Getting between 7 and 9 hours of sleep per night is the recommended daily amount. Sleep deprivation can increase stress, increase the chance of chronic disease (specifically cardiovascular disease), and reduce brain function—including inattention, hallucinations and blurred vision.⁷ Chronic sleep loss can result in a handful of health issues, including weakened memory, slowed metabolism, increased irritability and moodiness, hypertension, a weakened immune system.^{8,9} It has also been linked to obesity, diabetes, depression, bipolar disorder, and seasonal affective disorder.¹⁰ Employing strategies and tactics to regulate sleep, and foster a regular sleep-wake cycle, should be a priority.

CIRCADIAN RHYTHM AND MELATONIN

Increased use of light-emitting technological devices in recent decades further challenges our ability to maintain a regular sleep-wake cycle. Several studies have demonstrated, with conclusive statistical strength, that nighttime light exposure can suppress the production of melatonin, which is secreted by the pineal gland.¹¹ This suppression, in turn, hinders our ability to fall to sleep, and wake, on a regular schedule.

Several studies have demonstrated, with conclusive statistical strength, that nighttime light exposure can suppress the production of melatonin

The effect is particularly strong with bluish light, which has been researched heavily. In a telling study by Dr. George Brainard, eight subjects were exposed to different wavelengths of light. Researchers collected blood samples both before and after light exposures to measure melatonin levels. The results demonstrate that bluish light is particularly effective in suppressing melatonin.¹² Other, subsequent studies support these findings.¹³

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In a natural state, melatonin production by the pineal gland drops significantly in the morning, remains low during the day, and then rises considerably in the evening.¹⁴ This daily hormonal cycle is strongly influenced by light. Certain photoreceptor cells in the human eye, melanopsin retinal ganglion cells, are especially sensitive to blue light with short wavelengths of approximately 460 nanometers.¹⁵ When exposed to high doses of bluish light — whether generated by the sun, electric light, or smart devices — these cells send a message to brain to “shut down” the production of melatonin, and the brain retransmits this message to the pineal gland.¹⁶ In this way light, especially bluish light, reduces the body’s production of melatonin.

Melatonin suppression in the evening hinders sleep and disrupts the sleep cycle

This suppressive effect is naturally caused by sunlight during the day. It can also result from artificial light sources in the evening. This is important, because melatonin suppression in the evening (a relatively new phenomenon in human history brought about by electric light) hinders sleep and disrupts the sleep cycle.

Melatonin production may be suppressed by a variety of light sources but, as discussed above, the more bluish light produced by newer energy-efficient light bulbs, and electronics such as computer screens, smart phones, and tablets, is compounding the problem. Dr. Brainard explained that a large LED screen, for example, “could be giving you an alert stimulus at a time that will frustrate your body’s ability to go to sleep later.” And even when you turn it off, he says, “it doesn’t mean that instantly the alerting effects go away. There’s an underlying biology that’s stimulated.”¹⁷

12 Thapan, Kavita, Josephine Arendt, and Debra J. Skene. “An Action Spectrum for Melatonin Suppression: Evidence for a Novel Non-rod, Non-cone Photoreceptor System in Humans.” *The Journal of Physiology* 535 (2001): 261-67. Print.

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13 Ibid

14 Brown, G. M. “Light, Melatonin and the Sleep-wake Cycle.” *J Psychiatry Neurosci* 19.5 (1994): 345-53. Print.

15 Thapan, Kavita, Josephine Arendt, and Debra J. Skene. “An Action Spectrum for Melatonin Suppression: Evidence for a Novel Non-rod, Non-cone Photoreceptor System in Humans.” *The Journal of Physiology* 535 (2001): 261-67. Print.

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16 Macchi M, Bruce J (2004). “Human pineal physiology and functional significance of melatonin”. *Front Neuroendocrinol* 25 (3-4): 177-95. doi: 10.1016/j.yfrne.2004.08.001. PMID 15589268.

17 http://www.nytimes.com/2011/07/05/health/05light.html?pagewanted=all&_r=0



While the bluish light from new light sources has the strongest effect on melatonin levels, even bright standard room lighting has a noticeable impact.¹⁸ Conversely, light with longer wavelengths above 550 to 560 nanometers (more towards the orange or red end of the spectrum) has a much lower suppressive effect.¹⁹ Exposure to such light in the evening and at night, in lieu of bluish or regular lighting, has a less disruptive effect on the sleep-wake cycle.²⁰

The effects of melatonin suppression can be long lasting, just as jet lag may persist several days after a trip.²¹ Accordingly, maintaining a consistent schedule of the right kind of light exposure helps your body maintain a consistent sleep-wake schedule.

USING LIGHTING TO OUR ADVANTAGE

While certain types of lighting may negatively affect our sleeping schedules, there are ways to create lighting that can help our bodies maintain their natural rhythms. For example, research shows that illumination of less than 30 lux for 30 minutes should not significantly suppress melatonin production.²² In addition, using a light source that is skewed towards the orange and red end of the spectrum (in place of a more whitish or bluish light) will also reduce melatonin suppression that would otherwise be caused by a bluish, or even a traditional white, light source.²³ Engineering LED bulbs in this way can provide individuals with the illumination (quality and quantity of light) they need in the evenings and at night, but without significantly suppressing melatonin. This can help them maintain their natural sleep cycles.

18 Figueiro et al. found that even low levels (30 to 300 lux at the eye) of incandescent light in the home, for ½ hour have a significant effect (8 to 35% reduction) on melatonin level in humans (Mariana G Figueiro, Mark S Rea, John D Bullough, *J Carcinog* 2006, 5:20).

McIntyre et al. found that maximum suppression of melatonin following 1 hr of light at midnight was 71%, 67%, 44%, 38%, and 16% with intensities of 3000, 1000, 500, 350, and 200 lux, respectively (McIntyre IM, *J Pineal Res.* 1989, 6(2):149-56).

Gooley, et al. found that compared with dim light (< 3 lux), exposure to room light (< 200 lux) before bedtime suppressed melatonin, resulting in a later melatonin onset in 99.0% of individuals and shortening melatonin duration by about 90 min. Also, exposure to room light during the usual hours of sleep suppressed melatonin by greater than 50% in most (85%) trials (Joshua J Gooley et al., *J Clin Endocrinol Metab.* Mar 2011; 96(3): E463-E472).

19 Thapan, Kavita, Josephine Arendt, and Debra J. Skene. "An Action Spectrum for Melatonin Suppression: Evidence for a Novel Non-rod, Non-cone Photoreceptor System in Humans." *The Journal of Physiology* 535 (2001): 261-67. Print.

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20 Ibid

21 National Institute of Health, Circadian Rhythms Fact Sheet, http://www.nigms.nih.gov/Education/Pages/Factsheet_CircadianRhythms.aspx.

22 Thapan, Kavita, Josephine Arendt, and Debra J. Skene. "An Action Spectrum for Melatonin Suppression: Evidence for a Novel Non-rod, Non-cone Photoreceptor System in Humans." *The Journal of Physiology* 535 (2001): 261-67. Print.

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23 Ibid



While bright, bluish light in the evening works to disrupt our circadian rhythm, such light in the early day actually assists our body to maintain its natural rhythms.²⁴ The light works to suppress melatonin at the same time the pineal gland is ramping down melatonin production in the morning. Engineering an LED light source in this way for use in the morning also can help an individual maintain a natural sleep cycle.

There are ways to create lighting that can help our bodies maintain their natural rhythms

In addition to color (bluish versus orange/reddish) and intensity (brightness), distance from the light source to a person is an important practical factor, since how much light actually reaches the eyes is critical. Having higher light levels reach the eyes in the morning, coupled with lower levels reaching the eyes in the evening, generally is better to support our body's natural melatonin production and maintain sleep-wake cycles.

Finally, pairing the use of a relatively high volume of bright, bluish light in the morning with the use of non-bluish light in the evening would seem to be most effective at helping an individual maintain the natural sleep-wake cycle. Light bulbs or fixtures designed to provide this "recipe" of lighting — in place of traditional light sources — can benefit an individual seeking to get, achieve and maintain, a more consistent, natural sleep cycle.

CONCLUSION

Thanks to advances in technology, we are living in a "new age of illumination." While these advancements come with many benefits, we should also be aware of unintended effects they can cause to our natural rhythms around day and night, such as their ability to interfere with wakefulness and sleep. New innovations in the field of lighting, and solutions that help mimic natural light patterns, will be important, since they may help to the body back into, and maintain, its natural circadian rhythm.

24 Thapan, Kavita, Josephine Arendt, and Debra J. Skene. "An Action Spectrum for Melatonin Suppression: Evidence for a Novel Non-rod, Non-cone Photoreceptor System in Humans." *The Journal of Physiology* 535 (2001): 261-67. Print.

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