ATTACHMENT A

A RESOLUTION ACCEPTING THE NORTHERN TRANSITION ADVISORY COMMITTEE'S REPORT REGARDING OUTDOOR LIGHT POLLUTION
Resolution No. 132/2003-04

WHEREAS, the Carrboro Board of Aldermen finds the issue of light pollution to be of common concern to the community; and

WHEREAS, the Northern Transition Area Advisory Committee has been created to represent citizens of the Northern Transition Areas and is empowered to create reports and make recommendations to the Board of Aldermen related to preserving and enhance the character of the Northern Transition Area.

NOW, THEREFORE BE IT RESOLVED by the Carrboro Board of Aldermen that the Board of Aldermen accept the attached lighting report from the Northern Transition Area Advisory Committee subject to the following conditions:

1) That the planning staff is directed to create a draft ordinance amendment using the lighting report as a reference.

2) That any draft ordinance remove any reference to amortizing existing lighting fixtures, and;

3) That any proposed ordinance applies to residential as well as non-residential areas.

4) That provisions relating to street lighting not be included in the Land Use Ordinance but be included in modifications to the existing Public Works "Street Lighting Policy".

This the 9th day of March, 2004.

Memorandum

Date:
To: Mayor Nelson and Board of Aldermen
From: Northern Transition Area Advisory Committee
Re: A "Good Neighbors" Lighting Ordinance

The members of the Northern Transition Area Advisory Committee are concerned that Carrboro's Street Lighting Policy and Carrboro's Land Use Ordinance do not protect the town — and our area, soon to be part of town — from intrusive and unsafe outdoor lighting. We present to the Board a proposed lighting ordinance, to enhance the Town's existing Street Lighting Policy and Sections 15-242 and 15-243 of the Land Use Ordinance.

Reasons to revise the ordinance include:

1. An effective lighting ordinance helps the community maintain a high quality of life.
2. Correctly designed and installed lighting improves security in neighborhoods and homes.
3. Efficient outdoor lighting saves substantial amounts of money while it conserves energy. Good outdoor lighting standards lead to energy savings.
4. Wasteful, intrusive lights pollute the night sky; our proposed ordinance eliminates sky glow (light pollution).
5. Clear standards make effective enforcement possible.
6. A number of efficient lighting devices, particularly for lighting in the public right-of-way, are available to implement the intentions of the Ordinance.
7. The ordinance prevents light trespass onto adjacent properties and roadways.
8. Nighttime driving is safer because direct glare is reduced and pavement, buildings, and other surfaces reflect less bright light.
9. The Ordinance will encourage solar lighting where it is feasible.

The Ordinance contains the following main sections:

1. Section 15-343 contains important definitions. The Town's current lighting policy and ordinance lacks many of these.
2. Section 15-344 applies the ordinance to all nonresidential private and public light fixtures.
3. Section 15-345 exempts certain uses and lighting situations.
4. Section 15-346 describes what new development proposals must contain regarding their proposed lighting plans.
5. Section 15-347 contains the general standards that will be applied; 15-348 – 15-352 describe particular standards for particular uses and areas.
6. Section 15-354 requires all existing outdoor lighting fixtures to be removed or made to conform to the new Ordinance within five and one-half years of the enactment of the Ordinance.
7. Section 15-355 describes the techniques to be used in measuring light.

A common concern voiced about regulations such as the ones we propose is that such fixtures and controls might reduce public safety. In fact, research has shown that bad lighting itself reduces security, while well-designed and installed lighting is safer. Please refer to attachments: *4. Lighting and Crime, 6. Domestic Security Lighting and 7. Security Lighting.*

Also, please refer to Rutgers University's excellent website:
http://crimeprevention.rutgers.edu/brochures/lighting2/lighting.htm

In summary, the Northern Transition Advisory Board asks you to review this proposal carefully, ask other boards like the Environmental Review, Appearance and Planning Boards to give their recommendations, and receive the thoughts and comments of town staff. In the end, we believe you will support these modifications as improving the quality of life of residents in Carrboro as well as the Northern Transition Area.

An Introduction to the Issues of Light Pollution

We all win

by correcting the problems of inefficient outdoor lighting at night.

- Many types of outdoor lighting designed for advertising, security and visibility are actually wasteful, invasive and a source of disabling glare.

- "Light trespass", the poor control of outdoor lighting which crosses property lines, detracts from our quality of life, and confuses the instinctive daily and seasonal cycles of animals and plants.

- Although perceived as a deterrent to crime, studies by the US Department of Justice* and the National Institute of Justice* show no conclusive evidence that lighting actually prevents crime.

- Public hazards have been created by the use of glaring, high-wattage floodlighting along roadways and business parking lots, shining directly in the driver's line of sight.

- Public safety is also being compromised by businesses competing with light levels to attract business. The eye's inability to adjust quickly to drastic changes from light to dark, leaves a driver temporarily blind when exiting an overlit business area at night. It is not uncommon to see businesses using 3 to 6 times the recognized, lighting industry recommendations for site lighting (IESNA).

- The recent awareness of global warming concerns, due in a large part to power plant emissions, now demands an effort to reduce our consumption of electricity.

- Because of this unnecessary condition, many of our children today have already lost much of the starry night sky behind the glow of wasted light, limiting their imaginations to the man-made boundaries around them.

- By correcting these outdoor lighting problems for the future we can save money and electricity, improve public safety and increase visibility, while reducing air pollution and green house gas emissions.

* "Study of Streetlighting And Crime" 7/77 by James M. Tien / US Dept. of Justice • www.darksky.org/ida/ida_2/info63.html
"Preventing Crime, What Works, What Doesn't, What's Promising" A report to the US Congress / The National Institutue of Justice • www.ncjrs.org/works/wholedoc.htm

For more information, contact: The International Dark Sky Association 3225 N. First Ave., Tucson AZ 85719 • 520-293-3198 • website: http://www.darksky.org

C-2

The Institution of Lighting Engineers

Registered in England No 227499 Registered Charity No 268547 A nominated body of the Engineering Council

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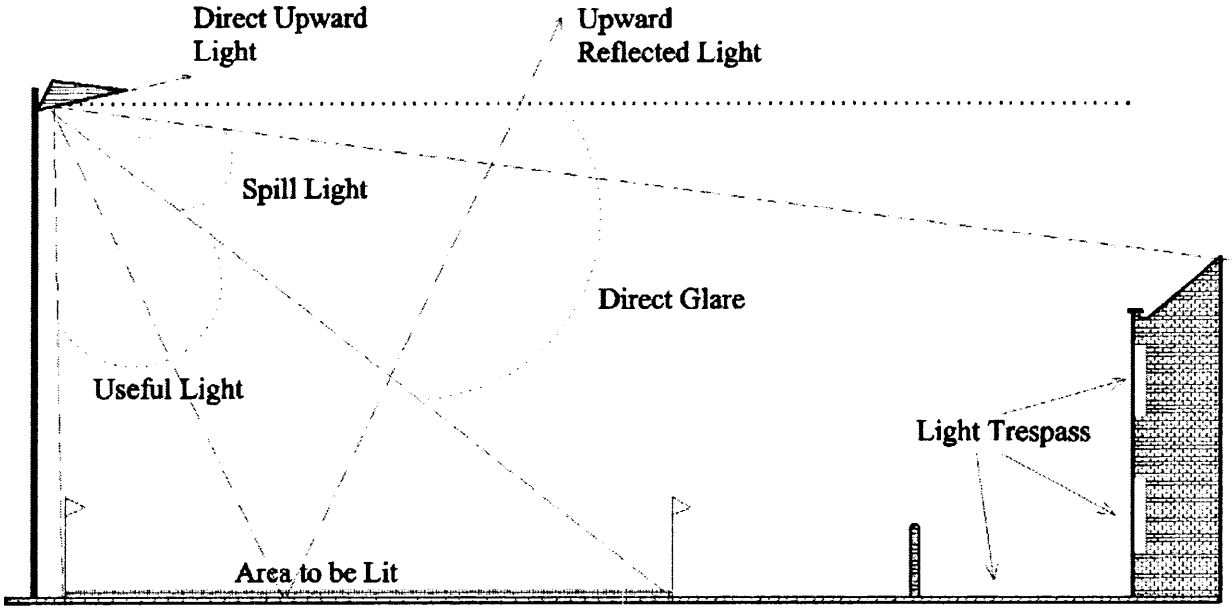
GUIDANCE NOTES FOR THE REDUCTION OF LIGHT POLLUTION

ALL LIVING THINGS adjust their behaviour according to natural light. Man's invention of artificial light has done much to safeguard and enhance our night-time environment but, if not properly controlled, **obtrusive light** (commonly referred to as light pollution) can present serious physiological and ecological problems.



Light pollution, whether it keeps you awake through a bedroom window or impedes your view of the night sky, is a form of pollution and could be substantially reduced without detriment to the lighting task.

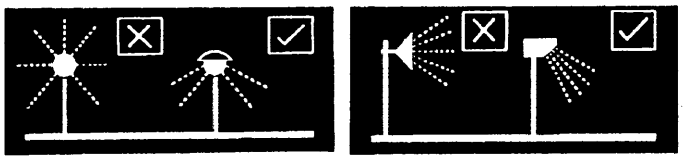
Sky glow, the brightening of the night sky above our towns and cities, **Glare**, the uncomfortable brightness of a light source when viewed against a dark background, and **Light Trespass**, the spilling of light beyond the boundary of the property on which the light source is located, are all forms of obtrusive light. This is not only a nuisance, it wastes electricity and thereby large sums of money, but more importantly it helps destroys the Earth's finite energy resources, resulting in the unnecessary emissions of greenhouse gases.

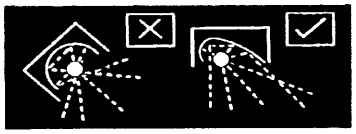
Listed below are some easy ways to reduce the problems of unnecessary, obtrusive light:

[A1] Do not "over" light. This is a major cause of light pollution and is a waste of money. There are published Standards for most lighting tasks. Organisations from which full details of these standards can be obtained are given on the last page of this leaflet.

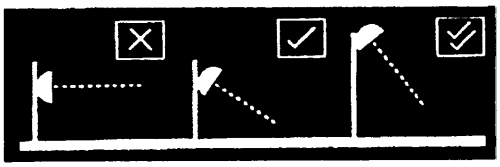
[A2] Switch off lights when not required for safety, security or enhancement of the night-time scene. In this respect one can introduce the concept of a curfew, i.e. a period in which more restrictive controls are applied to obtrusive light. In all new developments there is scope for Local Planning Authorities (LPA's) to impose conditions relating to curfew hours in determining planning applications. For instance, the LPA may determine that non- essential lighting, such as decorative floodlighting, should be switched off between 23.00hours and dawn. In the case of new non-residential developments, LPA's are encouraged to impose such curfews. In determining applications for illuminated advertisements, it is recommended that LPA's impose similar curfew hours. The attachment of domestic security and decorative lighting to residential buildings often does not require planning permission. However, as the floodlights are operational throughout the night it is considered that the after curfew levels of lighting control shown in Table 1 should be used at all times.

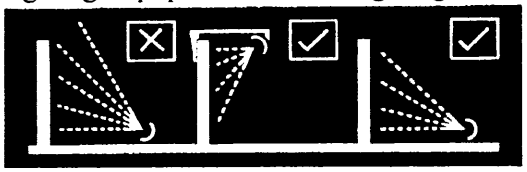
[A3] Use specifically designed lighting equipment that minimises the upward spread of light near to, or above the horizontal. Care should be taken when selecting luminaires to ensure that the units chosen will reduce spill light and glare to a minimum. The use of luminaires with double-asymmetric beams designed so that the front glazing is kept at or near parallel to the surface being lit will assist in the reduction of glare provided the units are correctly aimed. Similarly, modern well-controlled projector type luminaires, which can be aimed very precisely, can give an excellent cut-off beyond the lit area so reducing spill light and glare.





[A4] Keep glare to a minimum by ensuring that the main beam angle of all lights directed towards any potential observer is kept below 70°. Higher mounting heights allow lower main beam angles, which can assist in reducing glare. In areas with low ambient lighting levels, glare can be very obtrusive and extra care should be taken when positioning and aiming lighting equipment. When lighting vertical structures such as advertising signs direct light downwards, wherever possible, to illuminate them not upwards. If there is no alternative to up lighting, then the use of shields, baffles and louvres will help reduce spill light around and over the structure to a minimum.





[A5] For road lighting installations, light near to and above the horizontal should be minimised to reduce glare and visual intrusion (Note ULRs in Table 1). The use of full horizontal cut off luminaires installed at 0° uplift will minimise visual intrusion within the landscape as well as upward light. However in many urban locations luminaires fitted with a shallow bowl providing good control of light near to and above the horizontal can a provide a satisfactory solution whilst maximising the spacing of the luminaires.

ENVIRONMENTAL ZONES:
It is recommended that in their Development Plans, Local Planning Authorities specify the following environmental zones for exterior lighting control.

Category	Examples
E1: Intrinsically dark areas	National Parks, Areas of Outstanding Natural Beauty, etc
E2: Low district brightness areas	Rural or small village locations
E3: Medium district brightness areas	Small town centres or urban locations
E4: High district brightness areas	Town/city centres with high levels of night-time activity

Where an area to be lit lies on the boundary of two zones or can be observed from another zone, the obtrusive light limitation values used should be those applicable to the most rigorous zone.

TABLE 1 – OBTRUSIVE LIGHT LIMITATIONS FOR EXTERIOR LIGHTING INSTALLATIONS

Environmental Zone	Sky Glow ULR [Max %]	Light into Windows E_v [Lux] (1)		Source Intensity I [kcd] (2)		Building Luminance Before curfew (3)	
		Before curfew	After curfew	Before curfew	After curfew	Average, L [cd/m^2]	Maximum L [cd/m^2]
E1	0	2	1*	0	0	0	0
E2	2.5	5	1	20	0.5	5	10
E3	5.0	10	2	30	1.0	10	60
E4	15.0	25	5	30	2.5	25	150

Where: ULR = **Upward Light Ratio of the Installation** and is the maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky. (formerly UWLR)
E_v = **Vertical Illuminance in Lux normal to glazing**
I = **Light Intensity in Candelas**
L = **Luminance in Candelas per Square Metre**

Notes:

(1) **Light Into Windows** – These values are suggested maximums and need to take account of existing light trespass at the point of measurement.

* Acceptable from public road lighting installations **ONLY.**

(2) **Source Intensity** – This applies to each source in the potentially obtrusive direction, *outside* of the area being lit. The figures given are for general guidance only and for some large sports lighting applications with limited mounting heights, may be difficult to achieve. If the aforementioned recommendations are followed then it should be possible to further lower these figures.

(3) **Building Luminance** – This should be limited to avoid over lighting, and relate to the general district brightness. In this reference building luminance is applicable to buildings directly illuminated as a night-time feature as against the illumination of a building caused by spill light from adjacent floodlights or floodlights fixed to the building but used to light an adjacent area.

These limitations may be supplemented by a Local Planning Authorities own planning guidance for exterior lighting installations and you are therefore recommended to check with the Local Planning Authority before designing or installing any exterior lighting.

RELEVANT PUBLICATIONS AND STANDARDS:

British Standards:	BS 5489	Road Lighting.
Countryside Commission/DOE		Lighting in the Countryside: Towards good practice (1997) *(Out of Print)*
CIBSE Lighting Guides:	LC1	Code for interior lighting (1994)
	LG1	The Industrial Environment (1989)
	LG4	Sports (1990)
	LG6	The Exterior Environment (1992)
CIE Publications:	01	Guide lines for minimizing Urban Sky Glow near Astronomical Observatories (1980)
	83	Guide for the lighting of sports events for colour television and film systems (1989)
	92	Guide for floodlighting (1992)
	115	Recommendations for the lighting of roads for motor and pedestrian traffic (1995)
	126	Guidelines for minimizing Skyglow (1997)
	129	Guide for lighting exterior work areas (1998)
	136	Guide to the lighting of urban areas (2000)
Department of Transport		Road Lighting and the Environment (1993) *(Out of Print)*
ILE Technical Reports:	TR 5	Brightness of Illuminated Advertisements (1991)
	CP 2	Lasers, Festival and Entertainment Lighting Code (1995)
	TR24	A Practical Guide to the Development of a Public Lighting Policy for Local Authorities (1999)
		Domestic Security Lighting, Friend or Foe
ILE/CIBSE		Lighting the Environment - A guide to good urban lighting

USEFUL ADDRESSES:

British Astronomical Association (BAA)
Burlington House
Piccadilly
London, WIV 9AG
Tel: 020 7734 4145

British Standards Institution (BSI)
389 Chiswick High Road
London, W4 4AL
Tel: 020 8996 9001
Fax: 020 8996 7001

Commission for Architecture and the Built Environment (CABE)
The Tower Block, 16th Floor
11 York Road,
London, SE1 7NX
Tel: 020 7960 2400

Council for the Protection of Rural England (CPRE)
Warwick House
25 Buckingham Palace Road
London, SW1W OPP
Tel: 020 7976 6433
Fax: 020 7976 6373

English Heritage
23 Savile Row
London, W1X 1AB
Tel: 020 7973 3000

International Commission on Illumination (CIE)
Central Bureau
Kegelgasse 27
A-1030 Wien, AUSTRIA
Tel: (001) 431 714 3187
Fax: (001) 431 713 0838

Lighting Industry Federation (LIF)
207 Balham High Road,
London. SW17 7BQ
Tel: 020 8675 5432
Fax: 020 8673 5880

Royal Town Planning Institute (RTPI)
41 Botolph Lane,
London,EC3R 8DL
Tel: 020 7636 9107

Society of Light and Lighting
222 Balham High Road,
London, SW12 9BS
Tel: 020 8675 5211,
Fax: 020 8675 5449

Sports England
16 Upper Woburn Place
London, WC1H 0QP
Tel: 020 7273 1500

The Countryside Agency
Dacre House, 19 Dacre Street
London, SW1H 0DH
Tel: 020 7340 2900
Fax: 020 7340 2911

C-6

Good Neighbor OUTDOOR LIGHTING

PRESENTED BY THE NEW ENGLAND LIGHT POLLUTION ADVISORY GROUP (NELPAG) AND SKY PUBLISHING CORP.

What is good lighting?

Good outdoor lights improve visibility, safety, and a sense of security, while minimizing energy use, operating costs, and ugly, dazzling glare.

Why should we be concerned?

Many outdoor lights are poorly designed or improperly aimed. Such lights are costly, wasteful, and distractingly glary. They harm the nighttime environment and neighbors' property values.

Glare Here's the basic rule of thumb: If you can see the bright bulb from a distance, it's a bad light. With a good light, you see lit ground instead of the dazzling bulb. "Glare" is light that beams directly from a bulb into your eye. It hampers the vision of pedestrians, cyclists, and drivers.

Light Trespass Poor outdoor lighting shines onto neighbors' properties and into bedroom windows, reducing privacy, hindering sleep, and giving the area an unattractive, trashy look.

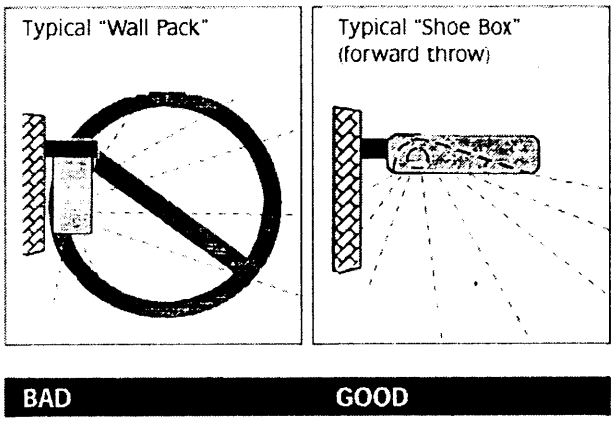
Energy Waste Many outdoor lights waste energy by spilling much of their light where it is not needed, such as up into the sky. This waste results in high operating costs. We waste over a billion dollars a year in the United States needlessly lighting the night sky.

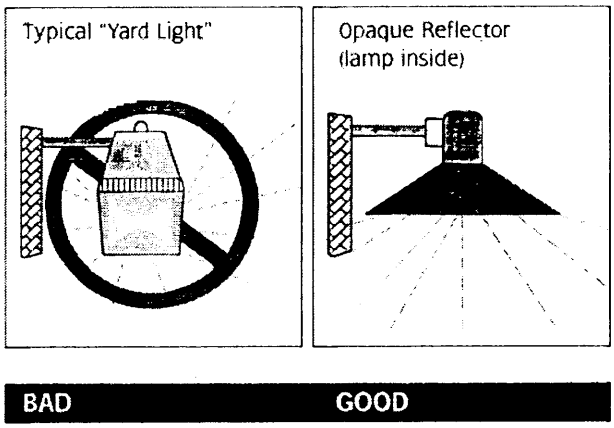
Sky Glow Rays that beam uselessly above the horizon create murky skyglow – the "light pollution" that washes out our view of the stars.

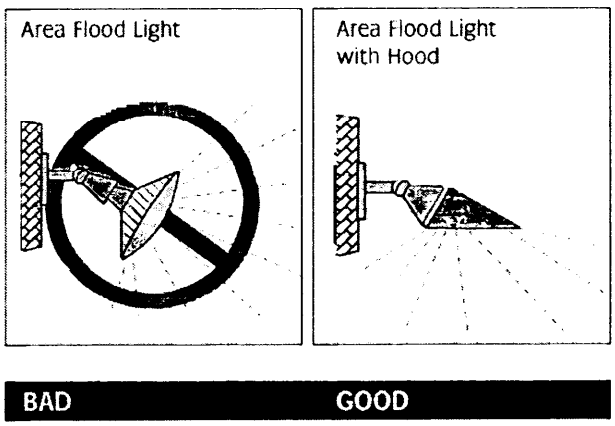
How do I switch to good lighting?

1 Provide only enough light for the task at hand; don't over-light, and don't spill light off your property. Specifying enough light for a job is sometimes hard to do on paper. Remember that a full Moon can make an area quite bright. Some lighting systems illuminate areas 100 times more brightly than the

Some Good and Bad Light Fixtures







full Moon! More importantly, by choosing properly shielded lights, you can meet your needs without bothering neighbors or polluting the sky.

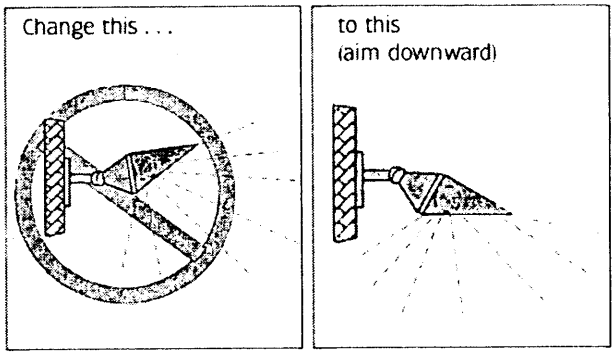
2. Aim lights down. Choose "full-cutoff shielded" fixtures that keep light from going uselessly up or sideways. Such fixtures produce minimum glare. They create a pleasant-looking environment. They increase safety because you see illuminated people, cars, and terrain, not dazzling bulbs.
3. Install fixtures carefully to maximize their effectiveness on the targeted area and minimize their impact elsewhere. Proper aiming of fixtures is crucial. Most are aimed too high. Try to install them at night, when you can see where all the rays actually go.

   Properly aimed and shielded lights may cost more initially, but they save you far more in the long run. They can illuminate your target with a low-wattage bulb just as brightly as a wasteful light does with a high-wattage bulb.
4. Choose energy-efficient low-pressure sodium (LPS) or high-pressure sodium (HPS) lamps wherever yellowish light will do the job. Use less efficient white lights only where ideal color rendition is important.
5. Where feasible, put lights on timers to turn them off each night after they are no longer needed. Put home security lights on a motion-detector switch, which turns them on only when someone enters the area; this provides a great deterrent effect!

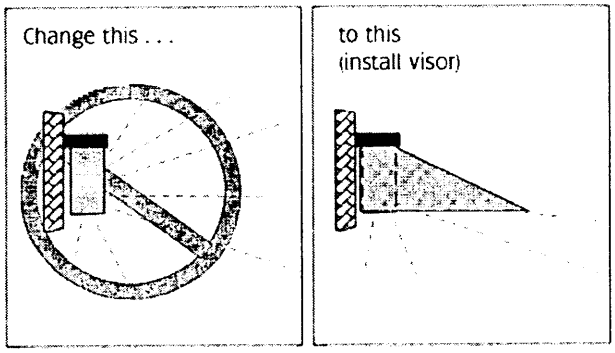
Replace bad lights with good lights.

You'll save energy and money. You'll be a good neighbor. And you'll help preserve our view of the stars.

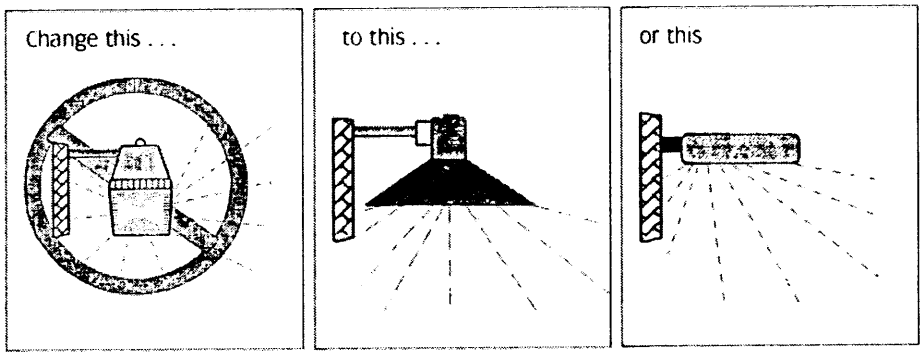
What You Can Do To Modify Existing Fixtures



FLOOD LIGHT



WALL PACK



YARD LIGHT | OPAQUE REFLECTOR | SHOE BOX

Presented by the
New England Light Pollution Advisory Group (NELPAG)
(http://cfa-www.harvard.edu/cfa/ps/nelpag.html) and
Sky Publishing Corp. (http://www.skypub.com/).
NELPAG and Sky Publishing Corp. support the
International Dark-Sky Association (IDA) (http://www.darksky.org/).
We urge all individuals and groups interested in the problems of light pollution and obtrusive lighting to support the IDA and subscribe to its newsletter. IDA membership costs $30 per year; send your check to IDA, 3225 N. First Avenue, Tucson, AZ 85719, U.S.A.

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Sky Publishing Corp.
49 Bay State Road
Cambridge, MA 02138
www.skypub.com

Unused Light, Overused Energy, Wasted Money

19 AUG 2001

Let's start this article about common-sense outdoor lighting with an "equation":

GLUT = Glare + Light Trespass + Uplight + Too Much Light

These are four negative factors often found with outdoor lighting. Not only does GLUT have a negative impact on our nighttime environment, the "nightscape" if you will, but it just doesn't make economic sense, either.

First, we'll take a brief look at each component of GLUT, and then we'll discuss some of the economic issues involved.

The 8th edition of the IESNA Lighting Handbook (1993) defines **glare** as *the sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort or loss of visual performance and visibility* . It stands to reason, then, that any good outdoor lighting design will minimize glare. If the light source itself is more apparent than what it is illuminating, then you have bad lighting.

Light trespass is light that is distributed where it is not wanted or needed. Streetlighting, for example, should light streets and sidewalks, not shine into second floor bedroom windows or illuminate rooftops. Also known as spill light, light trespass occurs whenever light shines beyond the intended target and onto adjacent properties.

Uplight is, in the truest sense of the word, wasted light. Light that goes directly up into the night sky is "lost in space" and serves no useful purpose. Uplight is the bane of astronomers and the occasional stargazer because atmospheric scattering artificially brightens the night sky, making distant celestial light sources difficult or impossible to see. Uplight often results from light fixtures which also produce glare and light trespass.

Too much light results when light levels exceed that needed for the task. Too much light often results from an unexamined "more is better" philosophy, or less innocent motives such as businesses trying to outshine their competitors.

Glare, light trespass, uplight, too much light ‹ all of these things waste energy. And energy costs money. And the money involved is significant, because the operating cost of a light fixture throughout its lifetime is usually much greater than the initial cost of the fixture. Besides, even when energy is cheap, each kilowatt-hour wasted produces the same amount of unnecessary environmental pollution due to the production of that energy, regardless of its cost.

It is interesting to note that a great deal of attention has been paid in recent years to light source efficiency, but relatively little consideration has been given to the equally important subject of light fixture efficiency. Granted, many lighting manufacturers and lighting designers are enlightened about the virtues of using efficient light fixtures, but for some reason the message is simply not getting out to the majority of electrical contractors, lighting suppliers, builders, developers, architects, government officials, and homeowners.

It is also important to note that an inefficient light source used infrequently costs less to operate than an efficient light source operated dusk-to-dawn, 4100 hours

per year. There are many situations where dusk-to-dawn lighting is often not required: security lighting, task lighting, parking lot lighting, to name a few. Time controls, occupancy sensors, or manual switches should be used whenever possible, with an appropriate light source, of course.

The most energy efficient light source available is low pressure sodium, but it is often criticized because of its monochromatic nature. But mix in a little metal halide or fluorescent light, and color rendering is much improved. The potential exists to utilize multiple light source types to achieve greater energy efficiency and a lower life cycle cost than with traditional single-source designs.

Finally, let's take a look at spectral power distribution as another dimension of lighting economy. Is it really necessary for a "white" light source to pump out photons at nearly every wavelength from 380 to 780 nm, as metal halide does? Our eyes are basically tetrachromatic: maximum sensitivity for red-sensitive cones is at 570 nm, green-sensitive cones at 535 nm, rods at 505 nm, and blue-sensitive cones at 445 nm. Could not an efficient pseudo-white light source be constructed that would emit virtually all of its spectral power at these four, or another set of wavelengths? Astronomers would love that, because most of the visible spectrum would be unaffected by our outdoor lighting, and a small number of narrow spectral lines would be relatively easy to filter out.

To summarize: maximum utilization of light output where and when it is needed at IESNA recommended levels makes good economic sense and will minimize adverse environmental impacts. Avoiding outdoor lighting GLUT (glare, light trespass, uplight, and too much light) will take us a long way towards that end.

The International Dark-Sky Association, a tax-exempt non-profit membership based organization, has been founded to help overcome this awareness problem and to help preserve dark skies while at the same time maximizing the quality and efficiency of nighttime outdoor lighting.

Economic Issues of Inefficient Outdoor Lighting

17 JAN 2002

Let's consider the energy use of inefficient outdoor lighting fixtures. A very common fixture seen everywhere throughout the United States, in cities and in the country, is the 175 watt dusk-to-dawn mercury vapor light. It is used for yard lighting, security lighting, and street lighting. It contains a photocell sensor switch to turn it on at dusk and off at dawn, hence the name "dusk to dawn". Quite a number of fixture manufacturers make such a unit, and many utility companies promote its use for "security" or "safety" at night. We see ads proclaiming "Light Up the Night", all in the interest of security or safety or some such thing. All this is in light of the fact that there is more crime in the daytime than at night, that there is more crime in well-lit areas than in dark areas (compare the light level in New York City to that in a typical rural midwestern city, and the crime level in both locations, for example).

A typical 175 watt dusk-to-dawn mercury vapor light.

Due to all this advertising, most of us have come to identify lighting at night (good or bad) with safety. The world runs on perception, not on reality. IDA believes that quality lighting can and does promote safety, security, and utility at night. We are definitely not opposed to quality lighting. We are definitely against poor lighting; lighting that causes glare, light trespass, urban sky glow, and that compromises visibility rather than helping us to see. Such poor lighting wastes light and energy and money.

Let's look at the 175 watt dusk-to-dawn mercury vapor light in some detail. It retails for $29.95 or even less. The system uses about 210 watts of overall energy when we consider the ballast and other factors. Most security lights and street lights are switched on and off by a photocell, sometimes as part of each fixture, sometimes controlling a group of fixtures. These dusk-to-dawn lights burn approximately 4100 hours a year (4100 / 365 = 11.23 hr per night), and this value is nearly independent of the latitude of the location, as the seasonal effects average out over the year.

Multiply: 210 watts x 4100 hours = 861 kilowatt-hours (KWH) energy used each year. At 8¢ per KWH (the national average electrical energy cost: some places are lower, but just as many are higher, some even twice as high), the average cost of operating such a lamp is about $69 per year. That is over twice the purchase price

of the fixture. Where energy costs are high, the annual energy usage costs over three times as much as the fixture or more. And this is for a fixture designed to last 20 to 30 years. Here we have a prime example of how those who look only at the initial cost are unaware of the real costs. We must take a long-term view. Tucson (about 600,000 population) probably had over 20,000 such lights until a mass change-over to better lighting sources was accomplished. (The local utility replaced several thousand of these mercury lights that they owned; think how many more are owned by private citizens.) So the annual operating cost of those mercury fixtures in Tucson alone was nearly 1.4 million dollars. The population of the United States is about 500 times that of Tucson. So the annual operating cost of that single type of fixture is over 700 million dollars. If all of these fixtures were replaced with quality 35 watt low pressure sodium fixtures (getting better lighting as well), the country would save over 500 million dollars per year.

Let us consider now the wasted light. At least 30 percent of the light coming out of the fixture is totally wasted (without even considering the energy inefficiency of the mercury lamp). It is light going up to brighten the sky, and light coming out at nearly horizontal angles. Such light only causes glare and light trespass, doing nothing to light up the owner's property, but doing a lot to offend neighbors like you. Some have estimated the wasted light at well over 30 percent. Have a close look at one of these fixtures. What do you think?

Wasted energy from a billboard. Courtesy Bob Crelin.

Thirty percent of $700 million is about 200 million dollars. That is money totally wasted. The wasted light is doing nothing to provide security, safety, or utility at night. It is only burning coal (most of the power in the United States is produced by coal burning), producing additional air pollution and acid rain. We have enough of that already.

Consider now all the other bad lighting. Billboards and other signs lit from below (much of the light output is wasted). Advertising searchlights. Lighting up of building facades with lighting fixtures that are not well controlled. Poor quality street lights, parking lot lights, and other area lighting. The many lights that burn all night whether they are needed or not. How many lights do you see nightly that have too much glare or too much wasted light? Look around! Let us conservatively assume that the added wasted light from all other outdoor light sources is five times the amount coming from the 175 watt mercury vapor lights.

Then the total wasted money being used to produce the totally wasted light is five times 200 million = One Billion Dollars a year!

Let's look at the amount of coal or oil being wasted to produce the wasted light. It takes, on the average, 0.47 tons of coal (940 pounds) to produce 1000 KWH of electricity, so one ton of coal can produce 2100 KWH of electricity. It takes about 1.8 barrels (76 gallons) of crude oil to produce 1000 KWH of electricity, so one barrel of crude oil can produce 556 KWH. The wasted light therefore equates to an *annual* waste of at least six million tons of coal (think of the added acid rain and air pollution!) or 23 million barrels of oil (think of the added oil imports). These are non-negligible amounts, to be sure.

While the wasted energy and money from any one person's poor fixture is not all that much (say, $5 to $10 a month added to their utility bill), the overall amount is truly "astronomical" (mind boggling) when one takes into consideration the sum of all these individual contributions. The solution is for each of us to do better, to be aware of the issues, and to eliminate wasted light wherever we can. We will save money and energy as a nation by doing more as individuals, at home and at work. We must.

All this wasted light and energy is doing nothing to promote safety, or a better life at night. In fact, it does the opposite. It costs us money and energy to have a trashy nighttime environment and to wipe out our dark skies. Bright skies, glare, and light trespass help no one. Glare never helps visibility; never. Light trespass often offends neighbors, and it is always unnecessary. Glare and light trespass are also factors in many accidents at night, by blinding or confusing drivers or pedestrians. All this costs the nation far too much in money and in pain. We shouldn't tolerate it. We must stop such waste. Now.

If we had a water sprinkler system that wasted much of its water by scattering water everywhere; onto the street, through our neighbor's windows, and upward to encourage evaporation, we'd not tolerate it for long. If together we wasted over a billion dollars a year this way, we'd declare it a national disaster and begin conservation measures and efficiency improvements immediately. We must build a greater awareness of the adverse effects of poor lighting and get on with the task of using only quality lighting.

For more information about these outdoor lighting issues, contact the International Dark Sky Association at the address at the beginning of this Information Sheet. Other information sheets available from IDA address the issues of energy savings (for example, the retrofit of street lights in San Diego to LPS is saving the city about 3 million dollars a year), the 175 watt mercury vapor light, the operating efficiencies of different kinds of light sources, and other quality lighting issues. Join us in our efforts to promote better outdoor lighting and energy savings. We will all benefit!

The International Dark-Sky Association is a tax-exempt member supported non-profit organization.

Exhibit 8: Proposed Good Neighbor Lighting Ordinance, November 17, 2003

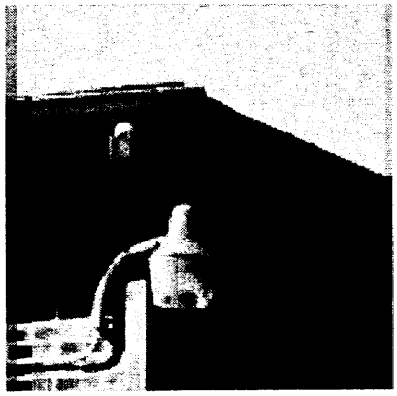
International Dark-Sky Association

The Typical Mercury Vapor Yard Light

19 AUG 2001

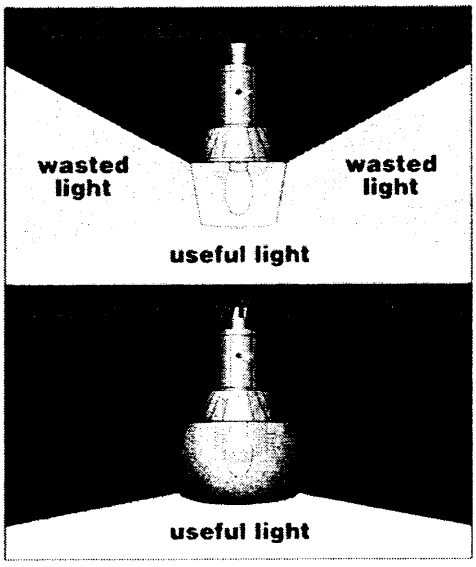
This cheap ($29.95 or less, usually) old fashioned fixture, used mostly as "dusk-to-dawn" lighting, is seen everywhere, and is particularly common as a "security light." It typifies most all the adverse effects of poor outdoor lighting: glare, light trespass, light pollution, and energy waste. It is, in reality, a very poor security light.

A typical 175 watt mercury vapor yard light.
This one is located in Randallstown, MD USA.



Much of the light emitted comes out of the fixture at angles where it is of no use in illuminating the ground or the area where light is needed. Consider an angle of 0° as directed straight down to the ground. An angle of 90° is therefore sideways, parallel to the ground, and an angle of 180° is straight up. Light emitted at an angle greater than 90° is uplight, and it is a cause of light pollution (sky glow). Light emitted at angles between 70° and 90° does very little to illuminate the ground, for it will not strike the ground anywhere near the source, and by then it is so faint that its effect in illumination is nil. However, it produces a great deal of glare (direct light striking the eye and dazzling or blinding the viewer). Glare is always bad; it never helps vision. At least 30% of the output is at these angles where it goes up, away from the ground, or where it only causes glare. This light is totally wasted, as is the energy that goes to produce it.

Let's consider the energy waste: A 175W lamp uses about 200 watts when one counts ballast losses as well. The lamps burn on average 11 hours a night; most security and street lights burn close to 4100 hours a year. Multiply: 200W X 4100 hours = 820 KWH of energy use per year. At 8¢ per KWH, about the average cost of electrical energy nationally, *each fixture* costs close to $66 per year to operate. This is over twice as much as the initial cost of $30. In an area where electricity costs 11¢ per KWH, the lamp costs 3 times as much to operate per year as it costs to buy it. This situation is a prime example of where those who look only at the front-end costs are making a big mistake. Our country is wasting too much energy. We must change.



Wasted and useful light from a typical barnyard security light with and without a Hubbell SkyCap shield .

A city the size of Tucson (600,000 people) could easily have at least 10,000 such lights. (That number is probably conservative.) So the annual operating cost of those fixtures in Tucson alone would be $660,000. If we consider 30% of the light output of such a fixture as wasted light (the up and sideways light) then the cost of the wasted light is close to $200,000 per year. And that is for just one city.

The U.S.A. has a population of about 300,000,000, or 500 times that of Tucson. So the cost of wasted light (doing no good at all for utility or security at night) is $100,000,000. From this type of wasteful fixture alone! Other poor lighting could easily contribute 10 times as much. Thus it is quite possible that the nation is wasting $1,000,000,000 (One Billion Dollars!) merely to light the sky and produce glare. None of that one billion is being used to light the ground, to provide safety or security, or a useful nighttime environ-ment. While light pollution does not directly cause illness (so far as we know), it is a major waste of the nation's resources. Do we tolerate such waste in other areas? Not when we are aware of it. We must become aware of this major waste, and put a stop to it!

In addition, this waste also means that we are burning a significant amount of coal and oil for no useful purpose, producing more waste and contributing to air pollution and water pollution as well. These effects are not negligible. Neither is the fact that the glare and confusion and clutter caused by the bad lighting are definite factors in accidents and losses caused by such. These also cost the nation too much in money and pain.

Light trespass is a serious complaint by many who live near these poor lights. Vandalism is a problem, too. Shooting out the lights kills the glare and stops light pollution, but it is not a real solution to the problem.

Another factor with mercury lamps is the lumen depreciation of the lamp. In five years or so the light output is down by a factor of two. Another five years, down by another factor of two. A mercury lamp never really burns out, it just gets fainter and fainter, using the same amount of energy to produce less light.

As a security light, this dusk-to-dawn fixture leaves much to be desired. It has a great deal of glare, blinding observers. The light output is harsh, and there are strong shadows. With the glare and shadows, it is most difficult to see, and it is easy for any criminal to hide. They don't mind this kind of light at all. The only "plus" factor is the feeling of security that the light generates in the unaware. Real security is lacking. Glare and brightness don't insure security. What to use instead, for a real security light? Three suggestions:

a. Use a low wattage (18, or 35, or 55 watt) low pressure sodium fixture, as a wall pack or with other mounting. There is lots of light, little or no glare (especially with a full cutoff or sharp cutoff fixture), and no sharp or deep shadows. One is not blinded, one can see. Visibility is the goal. These fixtures offer excellent visibility.

b. Use an infra-red sensor spotlight fixture. The spotlights only come on when the sensor senses movement. Any intruder will be scared off by the sudden turn-on of the spots. You are alerted. Energy use is minimal. What could be better? This type of fixture is a great security lighting system: effective, cost effective, quality lighting.

c. Use one or more low-wattage compact fluorescent lamps in well-shielded fixtures. The light level is adequate, and you save a great deal of energy.

The International Dark-Sky Association, a non-profit, tax-exempt, membership-based organization, exists to help preserve and restore dark skies while at the same time maximizing the quality and efficiency of nighttime outdoor lighting.

Exhibit 4: Proposed Good Neighbor Lighting Ordinance, November 17, 2003

International Dark-Sky Association — Information Sheet 51

Lighting and Crime

Does outdoor nighttime lighting prevent crime? The answer is nobody knows. There have been studies in the United States and in Europe examining this issue, and they have come to no definite conclusions that can be applied to society as a whole. Some studies suggest that lighting a particular neighborhood or park reduces the local crime rate. These types of studies often suffer from poor controls, poor scientific methodology, and failure to include long term follow-up. Other studies show no significant change in crime rates after the installation of lighting. If it were so easy to reduce crime with lighting, then we should have made considerable headway by now. Our cities have never been brighter, yet the crime rate is higher than ever. The connection between crime reduction and increased lighting is vague at best.

It is safe to say that good lighting in a park, neighborhood, or shopping mall may indeed bring more people out for shopping and recreation. If this is the case, there may be less crime, as more people are present. On the other hand, harsh excessive lighting with glare may give a trashy wasteland appearance to a street or neighborhood causing people to automaticallyassociate it with a high crime rate area. Think about how many places there are in our big cities that are brilliantly overlit and devoid of pedestrians.

There are anecdotal reports of increased crime and vandalism after the installation of lights. An article in *Building Operator* discusses how school districts across the country are actually turning off lights on school grounds to reduce vandalism. This also saves money by reducing energy use. There is no scientific evidence that nighttime blackout of lighting will always reduce vandalism, just as there is no evidence increased nighttime lighting necessarily reduces crime. A poorly conceived lighting program instituted by public hysteria over crime and vandalism can cause more harm than good. It often inflames public passions and magnifies the problem our of proportion to its true size. It offers people a solution that won't be effective, giving the public a false sense of security, and it wastes funds that could be spent on other social needs, such as more police or a better recreation program for school dropouts.

Is there the a public need for nighttime lighting? Of course there is. Numerous studies demonstrate reduced automobile and pedestrian accidents on properly lit busy roads and arterioles. Reasonable lighting levels are necessary for urban living. However, quiet suburban neighborhoods probably do not need any street lights whatsoever, or at most, lights only at busy corners. Malls and shopping center parking lots need reasonable lighting levels during business hours. After hours, the lighting levels can be greatly reduced or the lights entirely turned off. As in all cases with outdoor nighttime lighting, the lighting must be well thought out and well designed for the tasks at hand, keeping in mind the need for public security and recreation as well as the need to protect the beauty of the nighttime sky.

Exhibit 7: Proposed Good Neighbor Lighting Ordinance, November 17, 2003

Security Lighting: Let's Have Real Security, Not Just Bad Lighting.

19 AUG 2001

Clearly, what we all want and need is security and safety at night, at home and away from home, for ourselves, our families, our homes and property, and for all others. The task is to be safe, not just to feel safe. This means that we need effective and efficient lighting. Visibility is the goal. We want to be able to see well, rather than lighting the criminal's way. This goal exists for us at home, on the streets, in parking lots, at work, wherever. Good lighting can be a help, poor lighting always compromises safety.

Most crime actually occurs during the day, or inside buildings. However, we want the feeling and the reality of being safe outside at night. That does not mean putting in the brightest light we can find, blinding everyone in the area, creating light trespass, and lighting up the sky. What we do need is effective lighting, lighting that puts light where we need it (and nowhere else) and where it will help visibility. That means: no glare, no light trespass, no uplight, no harsh shadows, no steep transitions from light to dark, etc. Lighting by itself does not insure safety. Is there more crime in the "well lit" centers of large cities or in smaller towns with much less lighting? A cynic might derive a positive correlation between crime and light: the more light, the more crime. Current and past studies by competent crime authorities can be summarized as follows: "The paucity of data preclude any definitive statement regarding the relationship of lighting and crime, but there is a strong indication that lighting decreases the fear of crime." Quality lighting rather than poor lighting is essential for any real security.

Here are some examples of bad security lighting — lighting that often actually compromises safety. These poor quality fixtures can give the illusion of safety or the feeling of security, but in reality they don't add to safety at all; they may even make things worse. They are beacons to the criminal: "Come and get me, my lighting will help you, not me."

The 175-watt dusk-to-dawn "security light." This fixture was designed in the old days when energy was cheap, when there were no good lighting fixture designs, and when the adverse effects of bad lighting were not well appreciated. It sells for $29.95 or less, but uses over 200 watts of power. That means it costs about $70 per year to operate in most locations — much more in high electricity cost areas. Much of the light output is wasted, going up or sideways where it does no good at all. It has a great deal of glare, often blinding the homeowner and others. It splatters light everywhere, alienating neighbors. It casts harsh shadows behind trees and buildings, allowing criminals plenty of dark areas to hide in. It is a prime example of bad lighting. But it is in use by the millions throughout the country. Why? It's cheap, and bright. We see lots of glare so we think there is lots of light. But it's a most ineffective and inefficient light. (See IDA Information Sheets No. 3, 26, and 103 for more information.)

Globes. Again, light is splattered everywhere. Because it wastes so much light, one must put a high-wattage lamp inside to get any light on the ground. That means a great deal of glare is produced, so much that often one can't easily see the ground! Why are so many of these inefficient fixtures used? Mainly because they look good in the daytime! If one likes that look, then one should use only a very low wattage lamp (as in the days of gas lighting), preserving the daytime appearance and providing a nighttime "ambiance". One can install a separate, quality, lighting system to light the ground. There's no glare or light trespass from this good system, so it doesn't detract from the looks of the globes. One gets the desired attractiveness and also good lighting and safety. It costs more initially, but there is quality lighting.

Poorly shielded "wall packs" or similar fixtures. These also splatter light everywhere, some getting where needed but most is wasted. They also create lots of glare. Well

shielded wall packs can be excellent light sources, but one must be sure of what one is buying. Some wall packs have good light control, many nearly none.

Poorly designed or installed flood lights. Flood lights can be good, if they have good light control. But they must be well-designed and installed to take advantage of their pluses. Often they are poorly installed, aimed at what seems a random direction or, worse, right at the street (causing terrible glare for motorists) or at the neighbor's yard or bedroom window. We have all seen many examples of such bad lighting at night.

Here are some examples of good quality security lights:

A well-shielded low pressure sodium (LPS) fixture: well-controlled light, energy efficiency, no glare. A lack of color rendering is not a disadvantage for most security lighting. Visibility is excellent with LPS lighting.

A similar full-cutoff high pressure sodium (HPS) or metal halide (MH) fixture, or even the new low-wattage compact fluorescent PL lamps in good fixtures: no uplight and no glare.

Well-controlled and installed flood lights or spot lights.

The infrared sensor spot lights that come on only when someone walks into the field of view of the infrared (IR) detector. (They can activate an alarm too, if wanted.) These are very cost-effective and are most effective security lights. They scare intruders away, they offer good visibility to the homeowner when needed (e.g. when taking out the garbage, or when there is an intruder). They should be installed so as to put the light only where it is needed, not shooting up into the sky or onto the neighbor's property. Under the eaves is a good location, usually.

To see well, we need adequate light, but not too much. Too much can ruin our adaptation to less well-lit areas at night, blinding us just when we need to see. When we go from too bright to too dark or vice versa, we have poor visibility for a while. This effect is called "transient adaptation", and good designs should minimize its adverse effect on visibility.

To see well, we need to minimize any glare. Glare never helps visibility. To see well, we need to minimize dark areas near well-lit areas. This means good lighting design is required. Think, too, about energy savings. We should not waste light nor use inefficient light sources. We waste far too much energy and money (over a billion dollars annually in the U.S.A.) throughout the world due to poor lighting. Use light, don't waste it.

What else can we do to maximize safety at night? Here are some ideas (consult libraries, the local police, companies specializing in security equipment, and others for details and other ideas): use good locks, use a peep hole in the door to see who is there before answering the door, have an effective alarm system, include motion sensors (such as are used in the IR spotlight mentioned above), have good phone sense (what you say when answering the phone or on your answering machine), play the radio when gone, put indoor lights on a time switch, put good labels on your property (and put security labels on your windows), have a dog, join or promote a neighborhood watch program (one of the best ideas: promote quality outdoor lighting through such a group, too!), and so forth.

The International Dark-Sky Association, a tax-exempt non-profit membership based organization, has been founded to help overcome this awareness problem and to help preserve dark skies while at the same time maximizing the quality and efficiency of nighttime outdoor lighting.