

# **WHITE PAPER: Metal Halide (MH) vs High Pressure Sodium (HPS)**

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HPS is a better choice for outdoor lighting applications than MH for the following reasons:

1. Efficiency
2. Vision
3. Health
4. Environmental effects (flora and fauna)
5. Toxins
6. Financial costs

HPS provides better quality lighting at a lower cost and with less damage to the environment. Metal halide is much less efficient than high pressure sodium--MH produces much less light per watt; MH produces more glare due to the blue light component and increases adaptation time; MH more effectively shuts off melatonin production which can trigger tumor growth; MH contains more mercury within the bulbs; MH bulbs need to be changed more frequently; and MH costs more, overall.

For example, at 250 watts, mean lumen output per watt over the useful life of the lamp is 58 for MH vs. 87 for HPS; in other words, HPS produces 50% more mean lumens per watt. Even at 70 watts, mean lumen output is 45 for MH and 64 for HPS; in other words, HPS produces 42% more mean lumens per watt. 274% higher long term operating costs of MH as opposed to HPS not only because of lumen depreciation requiring more watts, but also because lamp replacement frequency is nearly twice as high.

Traveling from an area lit with MH will take the eyes longer to adapt to lower light levels, affecting night vision. Night vision is also more sensitive to the HPS spectrum due to the greater number of rods in the eye.

HPS lamps last longer than MH, which means fewer lamps heading for disposal (HID bulbs can be, but are often not recycled for their mercury content). In general the average lamp life for MH is 10,000-15,000 hours vs. 12,000-24,000 for HPS.

MH produces more sky glow, lumen for lumen, than HPS for the same quantity of radiant energy from each source, due to higher blue light component and the Rayleigh scatter effect. The paper at <http://resodance.com/ali/bluskies.html> suggests MH produces at least three times more sky glow than HPS due to the higher blue spectrum content and has a greater impact on dark-adapted astronomers.

MH lamps contain significantly more mercury than HPS lamps. For example, a 250W MH lamp contains about 38 mg of mercury vs. about 15 mg for an HPS lamp of the same wattage. Mercury is a potent neuro-toxin that persists indefinitely in the environment. The bluish light emitted by MH is much more of a threat to human health than the amber-to-gold light from HPS. From Science News <http://www.sciencenews.org/articles/20060107/bob9.asp> describing some of the research on this issue. Whenever MH is within close proximity to housing units, MH lighting will only increase the health risks.

High Pressure Sodium vs. Metal Halide  
Mean Lumens, Average Life, and Mercury Content  
 Data courtesy Long Island Power Authority

	High Pressure Sodium		Metal Halide	
	400W	250W	400W	250W
Mean lumens	45,000	26,100	20,500	14,100
Average rated life (hours)	24,000+	24,000+	15,000	10,000
Mercury content (mg)	15	15	81	38

The financial costs of cleaning up mercury in the environment (ground water) and for increased recycling facilities need to be factored into all costs. MH has a higher lumen depreciation rate for the bulbs which need to be changed more often.

The higher blue light component of MH is useful only during the day to “set” our hormonal clocks, which helps with Seasonal Affective Disorder.

Metal Halide exposure (in the studies conducted thus far in interior environments) has been determined to contribute to macular degeneration.

Coating MH with a “ceramic” coating to “change” the color is only partially effective; but further reduces it’s efficiency. Ceramics are better than "quartz" MH, but do not offset the negatives.

If “white” light sources are necessary, the use of compact fluorescent in 2300K will produce the desired results and more efficiently. The “need” for “white” light is not substantiated for exterior lighting situations, except in very rare circumstances, e.g. outdoor dining areas (rendering food colors better) and need only be used when those areas are being occupied. Fluorescent light sources are more efficient than MH.

Blue light affects hormone secretions. Blue light turns off melatonin production very successfully and thus raises the incidence of cancer tumor growth. Blue light is the trigger that shuts off the pineal gland; a gland which produces melatonin.

MH causes increased disturbances for plants and animals, changing their “signals” for nighttime behaviors and biological responses, especially in the “high” doses contained in High Intensity Discharge lamps. There are also “non-visual” (skin and eye receptors not used for vision) effects of optical radiation triggered with blue light at a higher rate. See: "The Ecological Effects of Artificial Night Lighting", Feb 23-24, 2002 hosted by the Urban Wildlands Group.

Regarding vision and glare, a fact that has not been fully studied, is that blue-rich white light literally forces the iris to constrict involuntarily as a defense mechanism to prevent retinal damage. Think about the “hurt” experienced when passing HID type headlights. Glare is greater with MH. The “dark adapted” eye is more sensitive to blue light. The blue aspect of MH produces a more debilitating “glare” problem than HPS, incandescent, or cf in 2300K. Consider how “painful” it feels when you are headed toward a car with the Xenox headlights, and how much longer it takes for your vision to “return” for you to be able to see with your own headlights. Additionally, the elderly are more prone to suffer profound disability from glare,

since their pupils contract and open much slower as the eyes age. Rensselear's Lighting Research Center also believes people with older eyes can't see well in the blue spectrum.

Driving vehicles under MH street lights and parking lot lighting allows less net light to enter the eye because of a constricted iris, while providing marginally greater "depth perception".

To learn more about the controversial issues relating to spectral distribution, current design standards, and how the eye reacts to different visible wavelengths check out the following papers online:

<http://luxbright.com/data/lumeneff.pdf>

<http://luxbright.com/lem/>

[http://www.iesna.org/LDA\\_3-99/members\\_feature\\_3-99roadscholar.htm](http://www.iesna.org/LDA_3-99/members_feature_3-99roadscholar.htm)

[http://www.dmdeng.com/learning\\_center\\_docs/Lewin\\_lamp\\_color\\_outdoor.pdf](http://www.dmdeng.com/learning_center_docs/Lewin_lamp_color_outdoor.pdf)

<http://www.dot.state.az.us/ABOUT/atrc/Publications/SPR/AZ522.pdf>

"Blue light waves are very short and scatter easily, so a great deal of the glare we experience from sunlight comes from blue light." (from "Macular Degeneration--The Complete Guide To Saving And Maximizing Your Sight," by Lylas G. Mogk, M.D. and Marja Mogk

Mercury is contained inside all HID and, to a lesser extent in fluorescent bulbs, and should be recycled and reclaimed, not discarded in landfills. The reason there was toxic mercury poisoning of the workers at the World Trade Tower site is because of the millions of fluorescent tube lights that were broken in the collapse.

From the US EPA/Purdue University site:

*When liquid mercury is exposed to air, harmful, invisible vapors are emitted. Spilling even a small amount of mercury can threaten the health of anyone who is present, and lead to an expensive cleanup. Moreover, when mercury gets into the environment, it concentrates in fish in a highly toxic organic form. Eating contaminated fish damages the neurological development of children, and especially of fetuses exposed when their mothers eat fish. It also can cause kidney damage.*

*When wastes such as fluorescent bulbs, broken mercury switches, batteries, or thermostats end up in landfills, the chemicals may escape into the groundwater or into the air. Mercury is particularly prone to volatilizing to air. Thus, many landfills do not accept this type of waste. Federal and state agencies regulate disposal of mercury-containing devices, even common small devices that are typically found in buildings.*

A more extensive comparison of HPS and MH is available at

<http://resodance.com/ali/compcost.html>

\*Seasonal confusion\* is greater with MH in trees and plants, not allowing the plant to go into dormancy when necessary to reduce winter stress.

When the proper calculations are made (not the simplified ones using "lamp lumens") the color of signs on the roadways (red and yellow STOP, construction, and warning signs) is as good or better with HPS than with MH. The reason is that HPS makes the red, orange and yellow sign materials brighter - for stop signs the red is about twice as bright under HPS as under MH. The Kelvin measurement of MH are highly questionable, too. The metric to determine validity of the

CRI calculation is called DC (for chromaticity difference) and MH exceeds the recommended tolerance (see CIE pub. 13.3-1995) by about 50%.

The Mercury Content of all MH bulbs is higher than HPS:

Metal Halide lamps (all)

39-50W = 1-10mg

70-250W = 5-50mg

350-400W = 30-100mg

400-1500W = 100-150mg

High Pressure Sodium standard (non-ECO)

35-1000W = 10-50mg

High Pressure Sodium ECO

50-400W = 1-15mg

High Pressure Sodium Plus ECO (30,000 hour non-cycling works on standard ballasts)

50-400W = <1-6mg

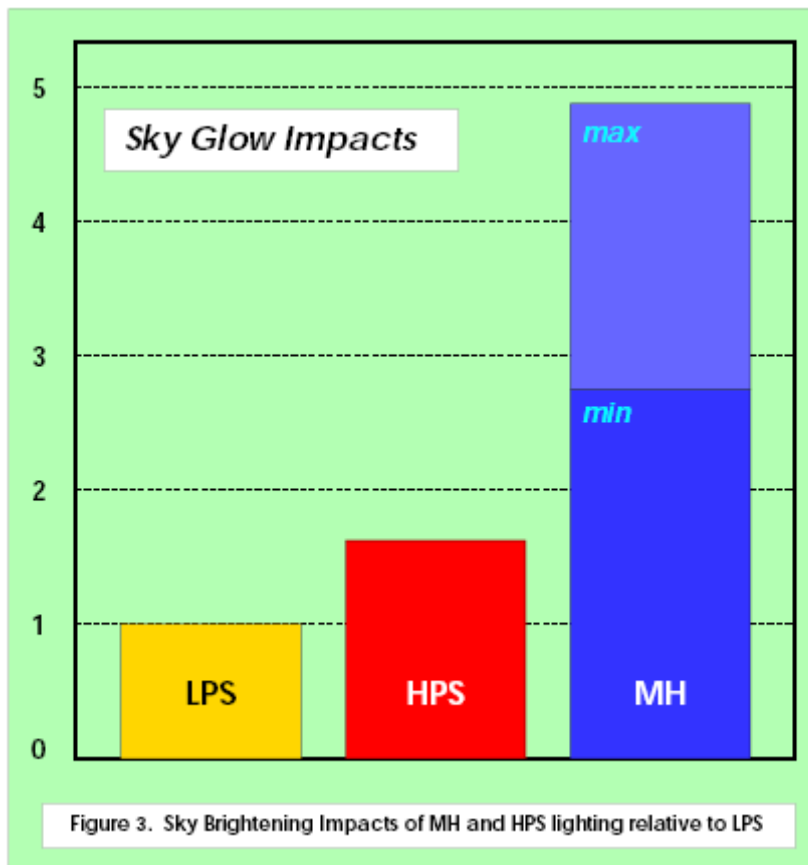
High Pressure Sodium Hg-Free ECO

ZERO

For all these reasons: many “dark sky” lighting codes and guidelines prohibit the use of MH, including East Hampton Village, Riverhead, Brookhaven, Amherst (MA), Hailey and Sun Valley (ID), Flagstaff, Tucson, Phoenix, etc.

## SKYGLOW

Skyglow is much greater with MH than HPS when used in the same quantities needed to meet IES light level requirements, some say as much as three to fifteen times as much.



MH is advocated by those in the "lighting industry" since it increases their profit margin. Unfortunately the "end costs" of the consumers are not a factor in the initial cost and design.

Along with research showing that MH lighting systems use 150%-170% of the energy, resources, equipment and (a substantially higher ratio of) maintenance costs compared to HPS, we also find that "uplight" from MH scatters in the atmosphere about twice as much as from HPS - for the same number of lumens. The same phenomenon (Rayleigh scatter) that makes the sky blue and sunsets/sunrises colored makes MH contribute twice as much to skyglow under clear sky conditions as HPS. This is not some esoteric concept but a long understood phenomenon (since 1871) that also doesn't get discussed during design discussions.

Consider this: a greener Earth, darker skies, cleaner landfills, cleaner water, air, land, brighter vision for the aged, improved traffic safety and reduced health impact VS "I like the way it makes colors look" and "I can see what-I-am-not-looking-at slightly better". people might wonder if 'pleasing' colors is enough justification to outweigh many other severely negative consequences that metal halide imposes on municipal infrastructures, business owners annual profit margins, and also upon the environment as a whole?