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Biologically Appropriate Lighting - Research Approach Recommendations

Additional submitted attachment is included below.

Biologically Appropriate Lighting

Research Approach Recommendations

To provide the best available science to achieve the environmental sustainability of the state's clean energy transition, more research is needed to address exterior lighting and its impacts on the environment. Recent studies show that significant near-term environmental and energy efficiency benefits can likely be achieved by integrating appropriate optical distribution, dynamic lighting controls, and spectral composition into today's exterior lighting design practices. To understand this fully and prepare recommendations for integration into California's Title 20, Title 24, and legislative opportunities (such as AB 38 introduced in 2022), existing recommendations from the biological literature should be compiled and prioritized. Simultaneously, addressing critical safety and visual barriers associated with spectral recommendations and advanced control systems must be tackled through laboratory and field research to identify best practices feasible within the broader end-user community and industry.

Establishing Research Needs Light pollution significantly impacts the biology of various species and is a critical environmental issue. Despite this, the ranking of contributors and their biological impact remains unclear.

Estimating and prioritizing different contributions from fenestration, street lighting, hardscape, and their regional variations is crucial for developing a well-crafted research strategy and supporting future standards modifications.

A regional application, potentially using "good, better, best" guidelines based on existing Lighting Zones, may be applicable. Researchers should work with relevant nonprofits, government organizations, and academics involved in the biological implications of light pollution. For instance, the European Union recently published a [comprehensive document](#) on the issue. The Australian government also published national [light pollution guidelines](#) for wildlife in 2020.

Coordination with relevant agencies and academic communities nationally and internationally is essential to establish baseline conditions. Efforts should align with organizations working in this area, including DarkSky (formerly the International Dark-Sky Association). In addition, this work should involve collaborating with relevant academic and nonprofit groups to gain a better understanding of the key contributors, the scope of light pollution, and early mitigation strategies.

Technology Evaluation Broad deployment of next-generation lighting control systems, alongside improved optics and light distribution systems can mitigate much of the light pollution issue. Current Title 24 sensor requirements for exterior lighting exhibit significant shortcomings, lacking performance attributes and specificity related to motion detection in real-world environments.

Applied research addressing lighting controls and sensor technology should focus on spatial and temporal features, their application in mitigating light pollution, and informing legislation. Research should also address cost-effectiveness and technological feasibility.

These deficiencies necessitate research efforts to address the evolving barriers associated with the broader implementation of cost-effective control strategies. Resolution of these issues can likely be achieved by establishing

a performance requirement in Title 24; however, this integration demands laboratory research and testing measurements to define it accurately.

Spectral Specificity Research Developing a biologically appropriate lighting specification requires specificity regarding spectral distribution recommendations.

Research should be done in collaboration with academics and biologists working on ecological light pollution. Work should prioritize, sort, and synthesize the existing spectral research from the biological community.

Ongoing research efforts in California and beyond have yielded varied recommendations for spectral controls aimed at minimizing disruption to species. To enhance this research, hosting roundtables and symposia is recommended to help collect valuable data and foster collaborative insights from key stakeholders.

Strategic Codes & Standards Research A robust engagement with codes and standards activities is essential, necessitating an in-depth exploration to better comprehend the current shortcomings of the opportunity through focused code research. Notably, Title 24 and Title 20 are deficient in addressing harmful light pollution. To address this, there is a pressing need to gain a better understanding of what the industry could feasibly support in the short-term concerning the advancement of a biologically appropriate lighting specification.

Research approaches should ensure a pathway towards a successful codes and standards strategy, tailored to specific applications and regions.

It is recommended that this initiative involve conducting roundtable discussions with industry and efficiency organizations. Additionally, a thorough technical analysis is crucial to understanding why different control scenarios are not being applied as part of today's standard practice. Substantial technical and economic feasibility issues are at play, requiring dedicated research and comprehension to formulate near-term recommendations for codes and standards.

Establish Industry Connections Research should establish partnerships with pertinent industry organizations (e.g., California Energy Alliance, National Electrical Manufacturers Association, Lighting Controls Association, Illuminating Engineering Society, etc.) to identify key research issues and proactively address potential barriers or pushback on research outcomes. The lighting industry and affiliated organizations are increasingly expressing interest and support for initiatives addressing light pollution. It is imperative to foster a robust industry connection and garner support for this work, emphasizing a comprehensive understanding of critical barriers associated with controls, optics, and spectrum.

Industry involvement is crucial in ensuring the cost-effective production of recommended technologies and design approaches resulting from this research.

Active participation in both the research phase and recommendation development is essential to mitigate potential roadblocks in implementation and codes and standards enhancement efforts.

Safety & Vision Research Opinions and concerns from the public and private sectors, including police, fire, logistics, and industry, need thorough vetting and consideration from a research perspective. In 2018, the UC Davis California Lighting Technology Center conducted limited color and vision research to better understand the impact of color temperature standards on visibility in the exterior environment in response to efforts to revise CALGreen in 2019.

Research should address visual performance, color discrimination, and glare issues concerning safety and vision for the proposed biologically appropriate lighting, encompassing considerations of intensity and spectral composition.

Color discrimination and perceived brightness are subjectively deemed crucial safety issues by the police community. Addressing biologically appropriate lighting necessitates specific spectrum and brightness recommendations, highlighting the critical need to enhance our understanding of the impacts of changes to spectrum and brightness on color discrimination and glare, considering visual acuity and potential downstream consequences. Collaboration with relevant safety and police organizations—such as CalTrans—at both the municipal and state levels is essential.

Given the time since the transition from high-pressure sodium (HPS) light sources with low correlated color temperature (CCT) to LED light sources with high CCT, any tangible benefits to public safety should be evident in municipal-provided surveys and data. In the absence of demonstrable improvements, a shift towards more biologically appropriate—lower CCT and minimal glare—lighting should be more readily pursued.

Environmental Organization Engagement The advancement of standards and legislative activities related to environmentally sensitive lighting can significantly benefit from close cooperation with environmental organizations.

Research should incorporate collaborative partnerships with pertinent environmental organizations to guide the research process and shape future proposed codes and standards measures.

Such collaboration not only offers valuable input and data but also provides essential institutional and educational support for the research and development of recommendations. Key organizations to engage in this collaborative effort include the National Audubon Society, DarkSky, Sierra Club, Natural Resources Defense Council, and astronomical associations.

Sincerely,

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