SSL Postings
U.S. DEPARTMENT OF ENERGY

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Increasing LED Efficacy: What We Stand to Gain

Greetings from Portland, OR, where we're gathered for DOE's tenth annual SSL Technology Development Workshop. A major theme at this year's event is how future lighting systems will go beyond merely lighting a space, with DOE focused on ensuring that energy efficiency doesn't get overlooked amid all the bells and whistles. Impressive increases in SSL efficacy have been realized in the past decade, as evidenced by the high-performing products now gaining share in a growing number of lighting-market niches. DOE R&D investments, in partnership with industry and academia, have helped spur the technology advances underlying this success. But given the magnitude of progress made to date, and the fact that LED technology could now be considered "good enough" to work in most lighting applications, the question arises: why continue driving for big gains in LED lighting efficacy?

There are five compelling reasons:

- First and foremost, **the potential energy savings are enormous**. Currently, the highest-performing LED technologies are a little more than halfway to the targets set forth in DOE's SSL R&D Plan, and analysis has shown that LED source efficacy can still be substantially increased — from its current leading level of 160 lm/W to the target of 250 lm/W — and that, similarly, LED luminaire efficacy can be increased from its current 125–135 lm/W to the target of around 200 lm/W. As market acceptance of LED lighting continues to grow, and as industry and government team up on the bold new approaches needed to reach DOE targets, Americans can realize annual savings on the order of 4.5 quads of primary energy by 2030. This reduction of 400 million tWhs of electricity consumption will yield $40 billion in annual cost savings in today's dollars.

- What's more, **in advancing LED efficacy, researchers will continue to realize scientific and technological progress on multiple fronts**. Research into improved LED efficiency already has yielded valuable insights into materials science, semiconductor physics, phosphor materials, quantum dots, power-supply components, and optical materials. This research is likely to have significant crossover into other clean-technology, consumer, and communications applications.

- In addition, **increased efficacy creates headroom for improving lighting quality and performance, lowering costs, and adding new services** that can be delivered through integration with controls and intelligence. That's because greater LED efficacy enables the production of more light with less electrical power at lower operating temperatures. As a result, manufacturers and designers can choose to reduce the light-source size, decrease the number of LEDs, increase the light output for a given source size, reduce electrical power input, reduce the amount of generated heat, or various combinations of the above.

- On top of all that, **improvements in efficacy will mean lower first costs**. In a growing number of market niches, LED products are becoming increasingly competitive against incumbent lighting technologies on a lifecycle-cost basis, factoring in their energy savings, longer lifespans, and lower operating costs. Nevertheless, most remain at a notable disadvantage on a first-cost basis. A competitive first cost is necessary to achieve the broadest possible market acceptance of LED lighting products. With continued R&D, LED products not only can compete head-to-head on first cost, but also have the potential to be less expensive than many incumbent lighting technologies. Greater efficacy is the key to these cost improvements.

- Add to all these benefits the fact that **efficacy-driven research can improve the competitive position of domestic LED manufacturers**. As an example, domestic manufacturers have focused on producing high-value, high-brightness LEDs, while Asian manufacturers have focused on lower-cost mid-power LED products. Currently, many LED lighting-product integrators are finding it cost-effective to use the mid-power LED packages as a light source. These products can have very good efficacy at low current densities, but suffer from droop at higher current densities, requiring a large number of smaller LEDs to reach typical lighting levels. If droop efficiency losses can be mitigated, then high-brightness LED packages can be run at even higher flux levels per package, reducing the effective cost per lumen. This would alter the cost-performance tradeoffs between mid-power and high-brightness LEDs, to the clear benefit of domestic LED manufacturers.

If the U.S. is to realize the full energy-savings benefits from LED lighting, a continued focus on LED efficacy will be essential, along with the rapid translation of that progress into high-quality, cost-competitive products that achieve broad market acceptance. The marketplace has been receptive to LED lighting products in niches where they provide performance and lifecycle-cost advantages over incumbents. Now, in addition to continuing to displace incumbent products, manufacturers need a compelling value proposition that gets those early-adopter customers to upgrade from 2010 products to future products that perform much better. With more-efficacious LEDs, manufacturers and designers can create the high-value products and applications that will keep buyers coming back for more.

As always, if you have questions or comments, you can reach us at postings@akoyaonline.com.