U.S. DEPARTMENT OF ENERGY

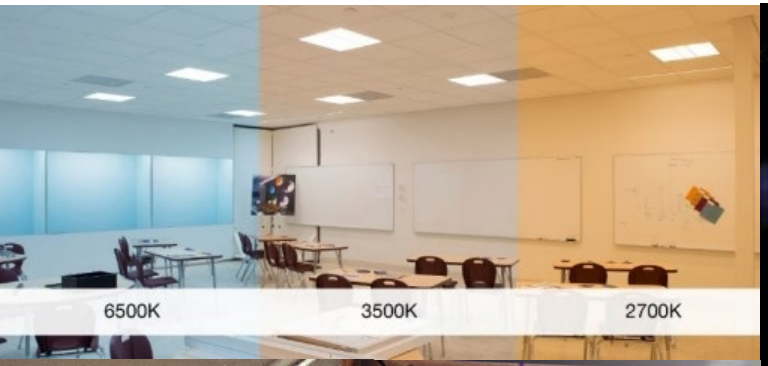
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

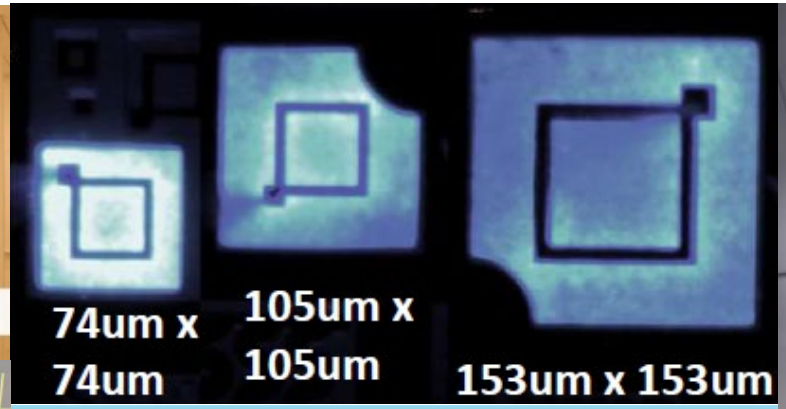
Lighting R&D Workshop *Welcome*

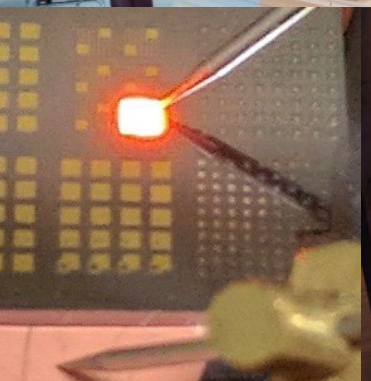
David Nemtzow, Director, Building Technologies Office

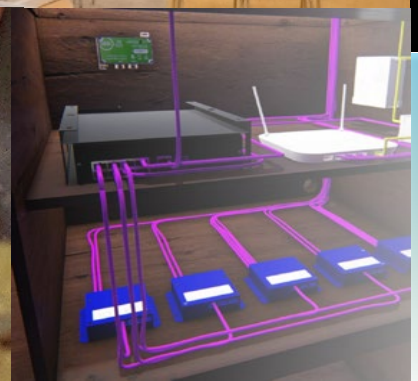
U.S. Department of Energy

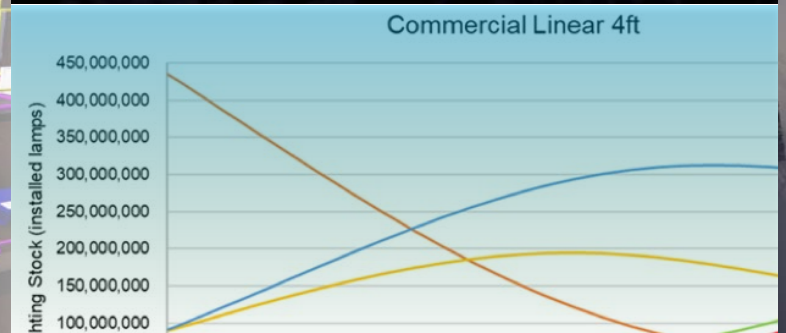
February 1, 2021

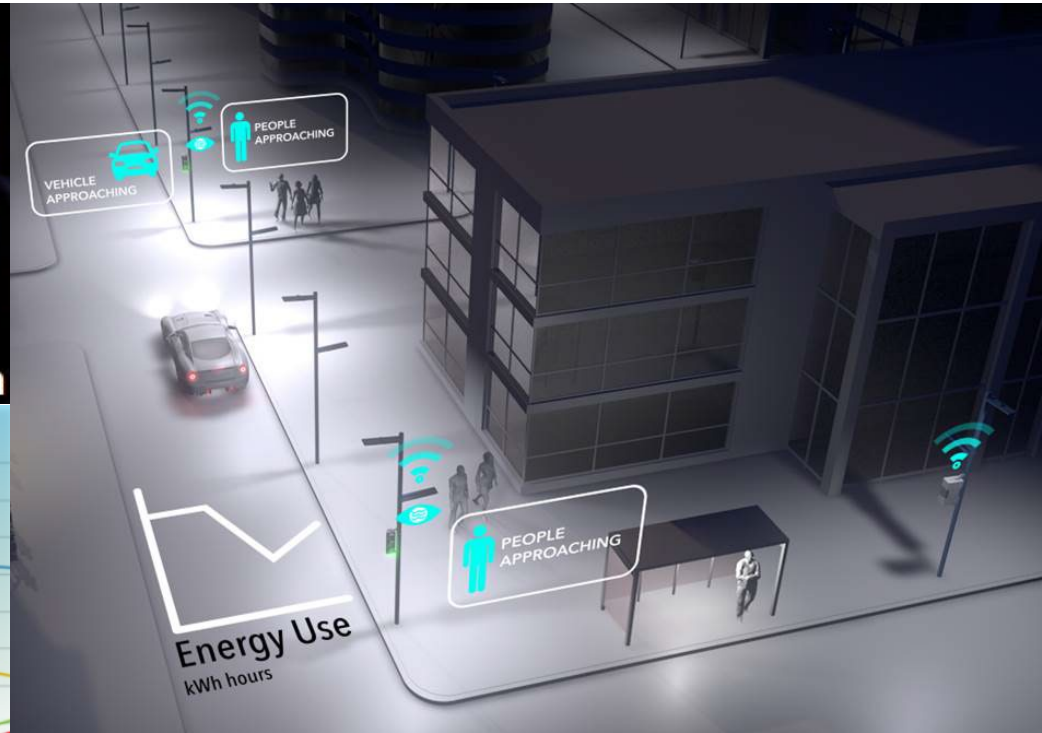








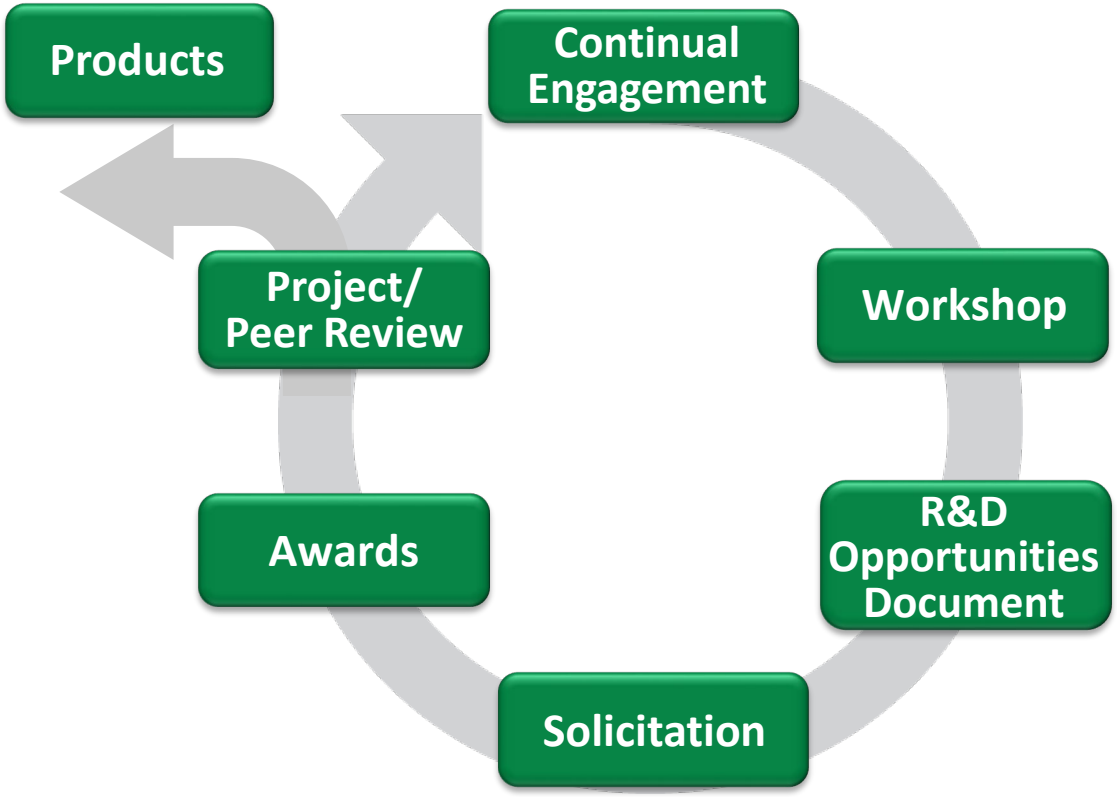





Mike Chan, Canada
Zheng Ma, Denmark
Christian May, Germany
Steve Fotios, United Kingdom
Laura Bellia, Italy
Alberto Elementi, Japan
Gerold Agustin, Hawaii
Ruth Genevieve Ong, Australia

The Wheel Keeps Turning

SSL community input from workshops and small topical meetings shape R&D priorities and DOE solicitations

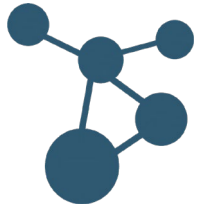


Next edition: Summer 2021

https://energy.gov/eere/ssl/research-development

Lighting R&D Results to Date

Attributable to DOE program



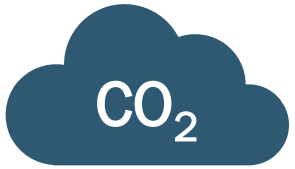
335
Projects

431
Patents

346
Products

Attributable to LED adoption (DOE's lighting market model)

140
Billion kWh saved per year



98
Million Tonnes CO_2 per year

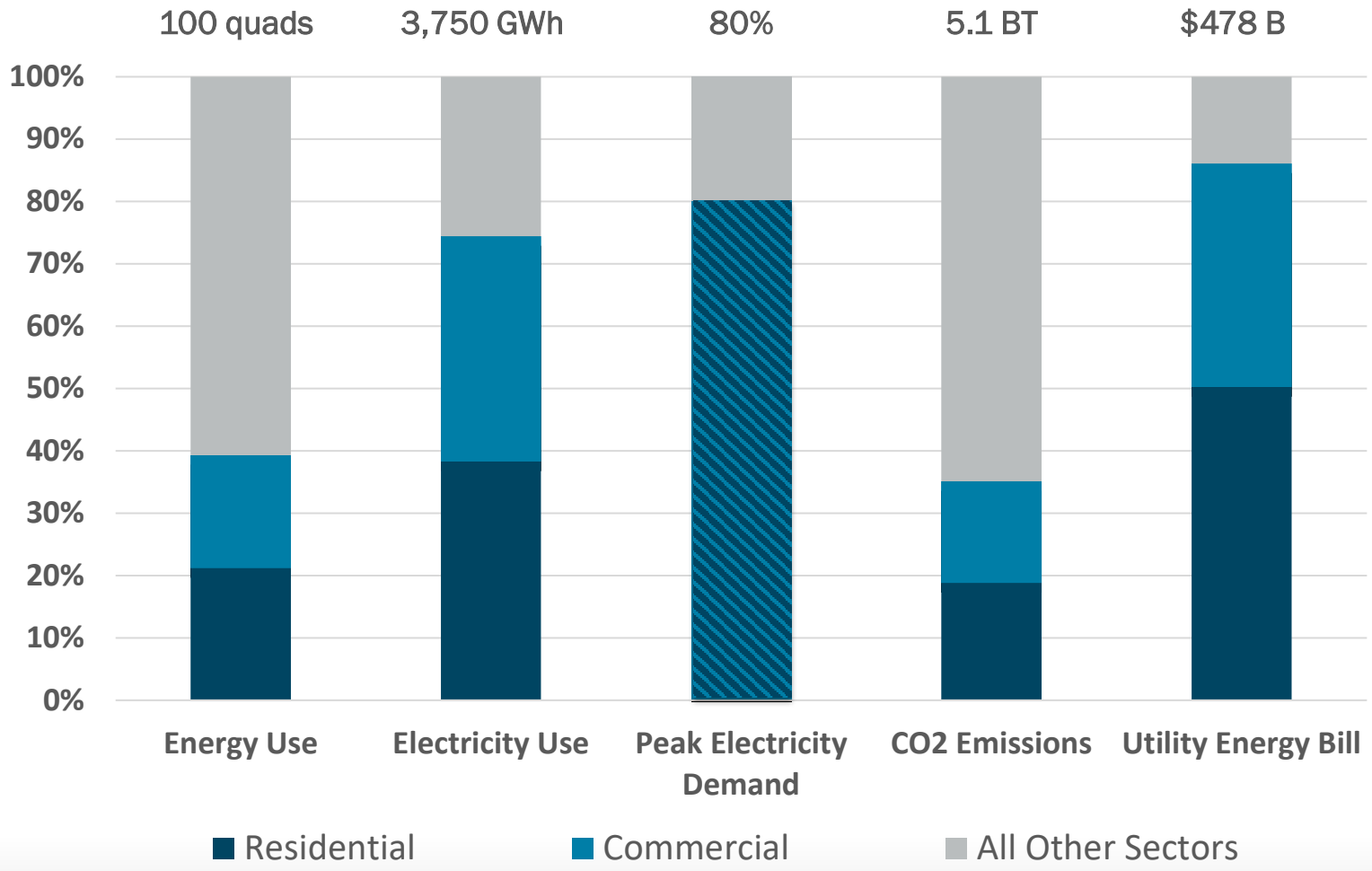
14.7
Billion energy costs avoided per year

Buildings are the largest sector of the US energy economy

120+ million buildings in the U.S.

~50%
≥ 40 years old

≥ 30+% energy is wasted



Building energy use is complicated

SECTOR

113.6 million housing units

224 billion sq. ft.

21 quads

5.6 million commercial buildings

87 billion sq. ft.

18 quads

CONSTRUCTION TYPE

- New Construction
- Retrofit
- New Construction
- Retrofit

Sample Envelope Types

- Masonry
- Wood frame
- Metal frame

BUILDING USE

- Single-Family
- Multi-Family
- Manufactured Housing
- Food Service
- Retail
- Hospitality
- Real Estate
- Education
- Healthcare
- Grocery
- Public

CLIMATE

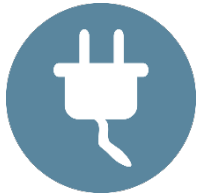
- Marine
- Cold/Very Cold
- Hot Humid
- Hot Dry/Mixed Dry
- Mixed Humid

Technologies include:

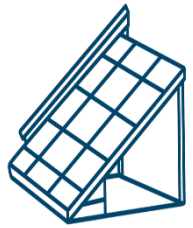
Buildings are key to decarbonizing the US economy

Buildings are an important part of the decarbonization solution and have critical connections to the health, prosperity, and happiness of Americans

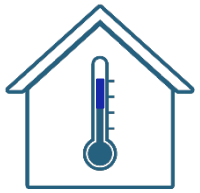
Building retrofits and efficient equipment can reduce the need for energy supply, while cutting customer energy bills by up to 38%.



Electrification of building equipment can **cut direct emissions** by 12%.

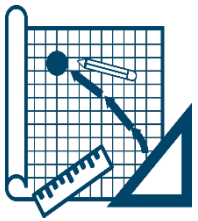


Buildings provide an opportunity to **coordinate and optimize DERs** (PV, EV, batteries).



Emerging thermal energy storage from buildings provides great promise to further deep **energy storage options**.

Smart technologies can further optimize building equipment to help reduce expensive peak load and shift time of energy use.



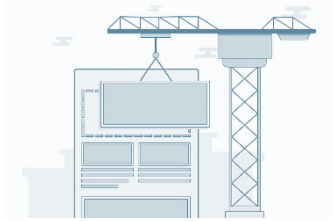
Passive design and **smart energy management** can increase the **resilience** of homes and businesses while reducing energy bills and improving occupant comfort.

Approaches to maximize carbon reductions

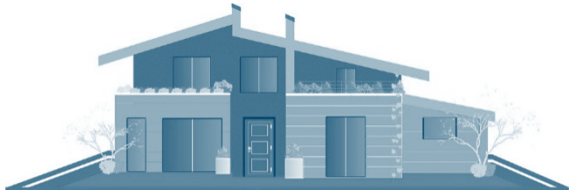
Achieving deep decarbonization in the new construction sector will require a variety of strategies that match energy efficient technologies and strategies with the needs of various market actors.

Advanced Building Codes

Codes offer an opportunity to embed resiliency and GEB technologies as well as advance priorities such as electrification and the promotion of DERs



Zero Energy Buildings



ZEBs when strategically paired with demand flexibility and energy storage have the potential to offer resilient, safe, operational buildings in case of natural disaster.

Embodied Carbon

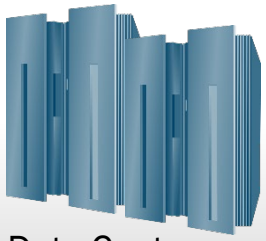
Embodied carbon emissions from the building sector produce 11% of annual global GHG emissions, and approximately half of all the emissions from new construction between 2020 and 2050 will be attributable to embodied carbon.

Energy-Intensive Buildings

Energy intensive buildings typically are host to either societally critical or high-value-add activities. Examples include:

Hospitals

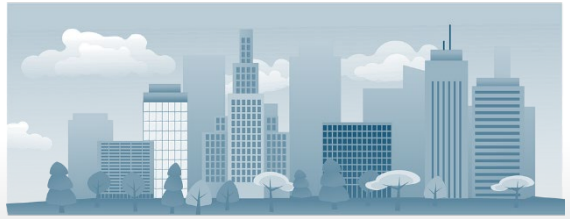
Restaurants



Data Centers

Community-Based Efficiency

Emphasis on energy investments benefitting people from all backgrounds, focusing on communities who have suffered the most from pollution, including low-income rural and urban communities, communities of color, and Native communities.



BTO: 8-10 Year Strategy

BTO Priorities

1) **Aggressive, Accelerated Energy & Carbon Savings:** Advanced research, development, commercialization & deployment of next-gen technologies, materials, practices

2) **Lock-in Savings with Codes & Standards:** Accelerated, aggressive appliance & equipment efficiency standards & building codes, incl. building performance standards for existing buildings.

3) **Grid-interactive loads/Demand flexibility:** Enable buildings to quickly shift their power demand in response to grid & other signals for renewables integration, peak management, etc.

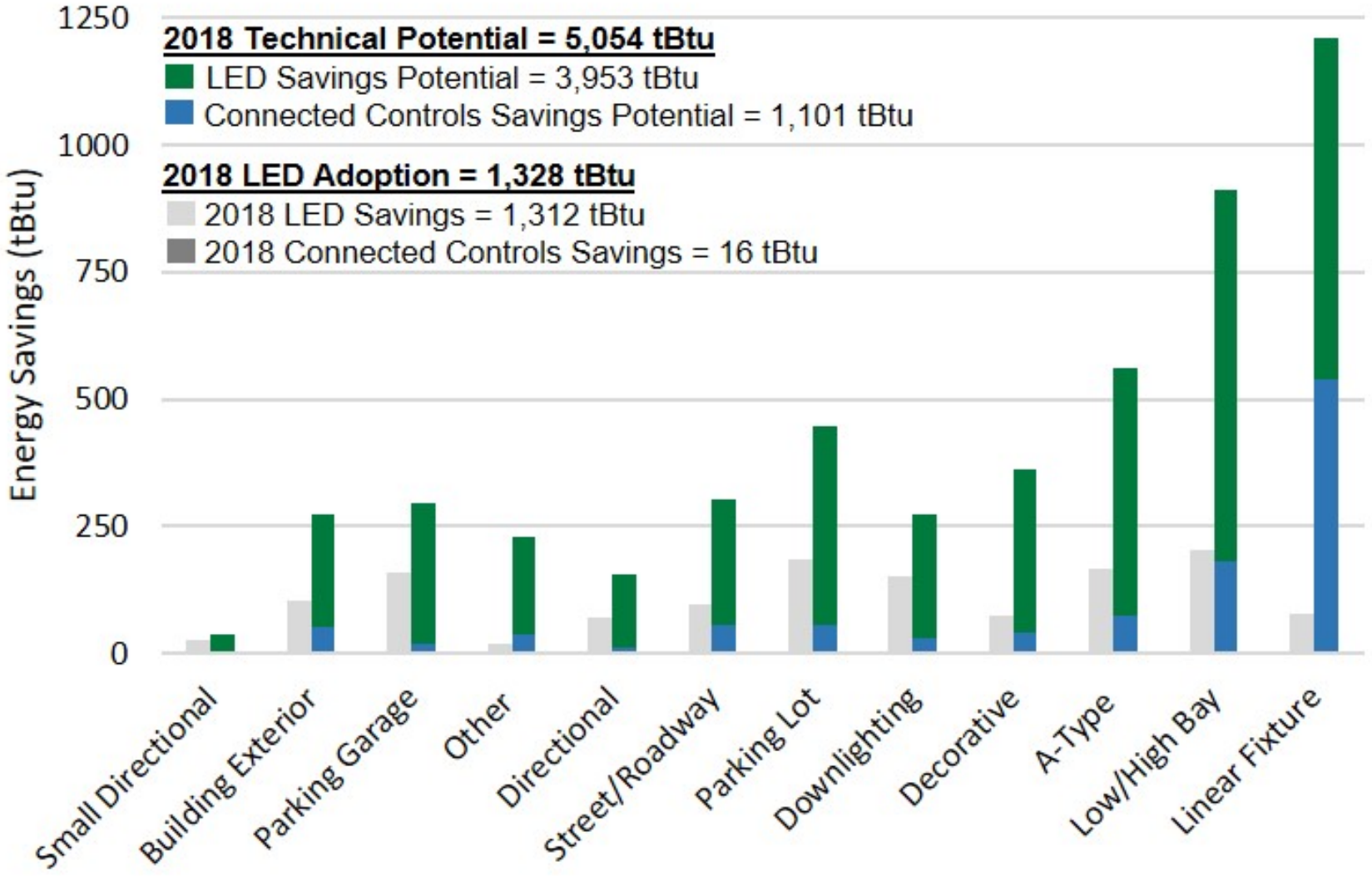
4) **Advanced building construction practices deployment:** Quick, efficient, and cost-effective high-quality residential and commercial building upgrades; focus on equitable solutions and on reduced embodied carbon

5) **Beneficial Electrification:** Electrify end uses via market transformation to cost-effectively reduce CO_2 emissions and improve occupant comfort, productivity, health

Key Goals by ≤2030

- ✓ 30% reduction in energy use intensity in buildings from 2010 levels
- ✓ Support the achievement of key Administration goals:
  - Upgrading 4 million buildings
  - Creating >1M good-paying jobs w/choice to join union
  - Spurring construction of 1.5 million sustainable homes and housing units
  - Decarbonizing US power grid
  - Standards & codes are in place, on time
  - Other Administration bldgs-related priorities & goals
- ✓ All new commercial construction is net-zero energy; advanced building construction practices in common usage
- ✓ Buildings can provide the needed demand flexibility to for renewables integration, affordability, reliability/ resilience
- ✓ Continue transforming lighting

Progress and Potential for Buildings also holds for Lighting



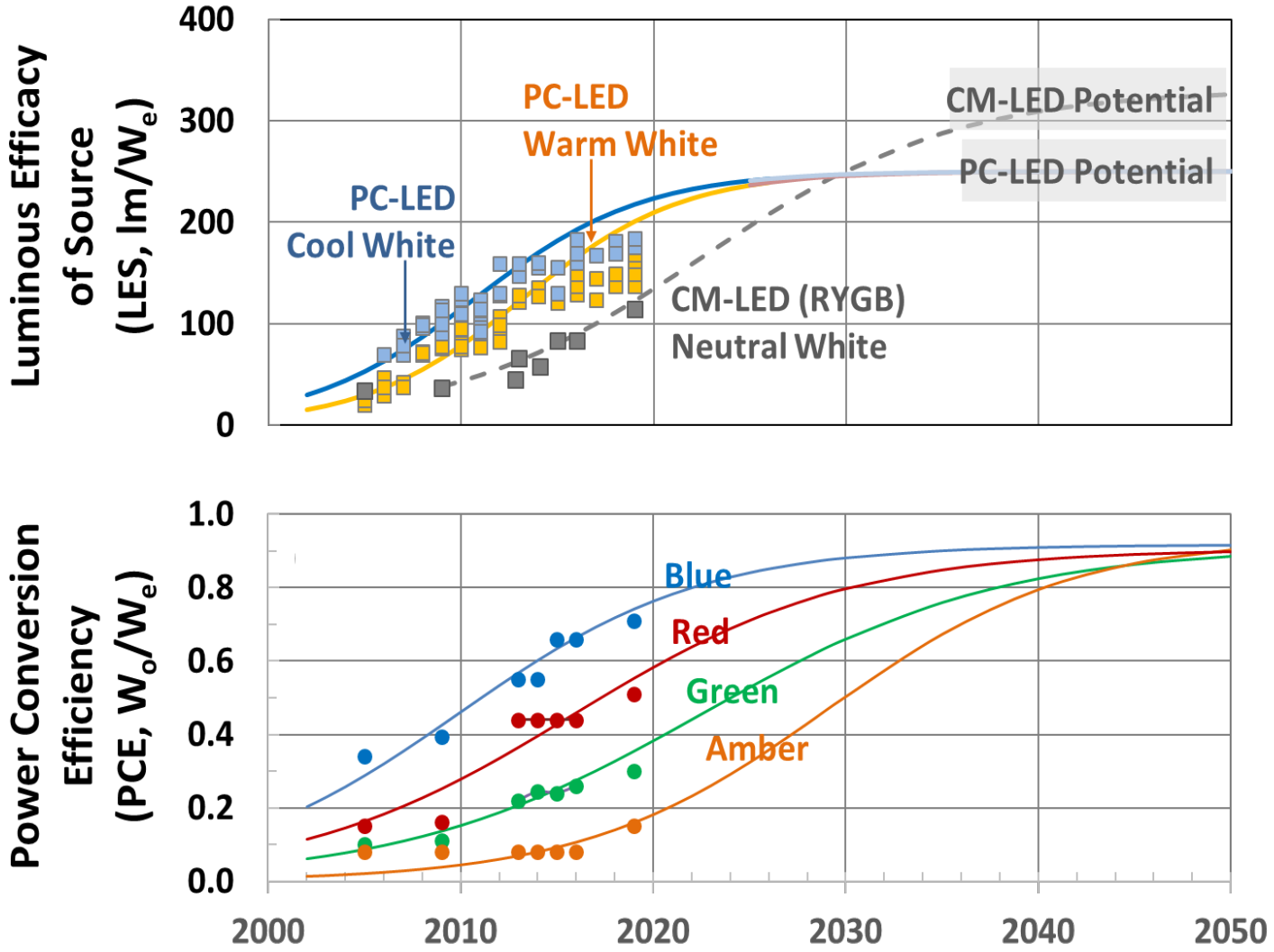
Low/high bay, parking lot and garage, and A-type LED products currently save the most energy.

In contrast, linear fixtures offer the highest savings potential.

Progress in control technologies will be key to unlocking the full potential energy savings.

www.energy.gov/eere/ssl/led-adoption-report

LED Program Targets

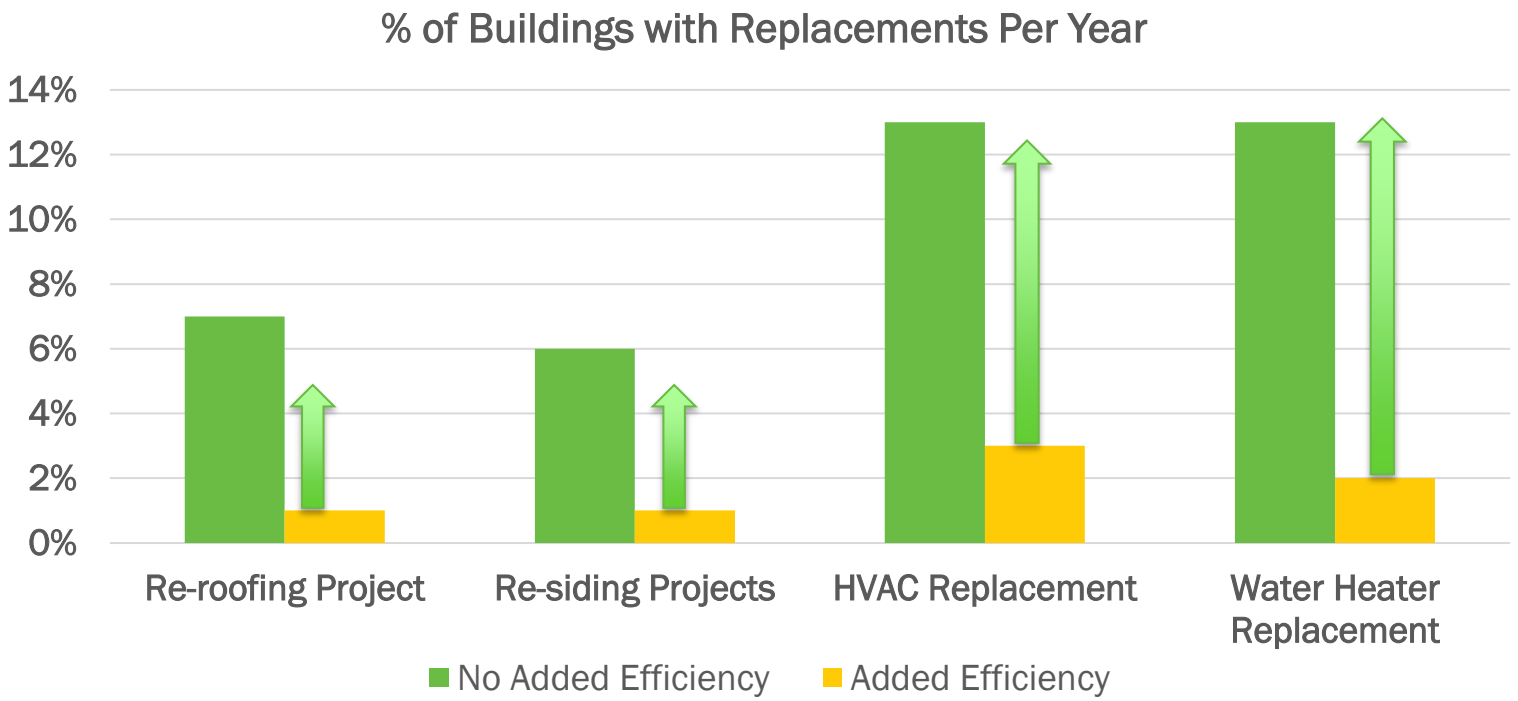


Best-performing LEDs are only halfway to ultimate DOE goals

Significant technology development headroom remains

www.energy.gov/eere/ssl/downloads/2019-lighting-rd-opportunities

Near-term opportunities for high impact market transformation focus areas



Near-term opportunities based on market, performance and programs:

- Grid-interactive heat pump water heaters
- Heat pump HVAC systems with smart thermostats
- Connected lighting
- Thin triple windows

BTO Market Transformation Support Activities

- Analysis & identification of market acceleration opportunity
- Determine collaboration & partnerships for market pull
- Produce unbiased, validated information
- Leverage funding for innovation & validation
- Promote skill development & training programs
- Provide national recognition through market engagement
- Develop Codes & Standards

Focus on technologies that are primed to enter the market, and drive adoption through holistic market transformation

Beyond Legacy Functionality: It's not (only) Lumens per Watt

Lighting…and health impacts

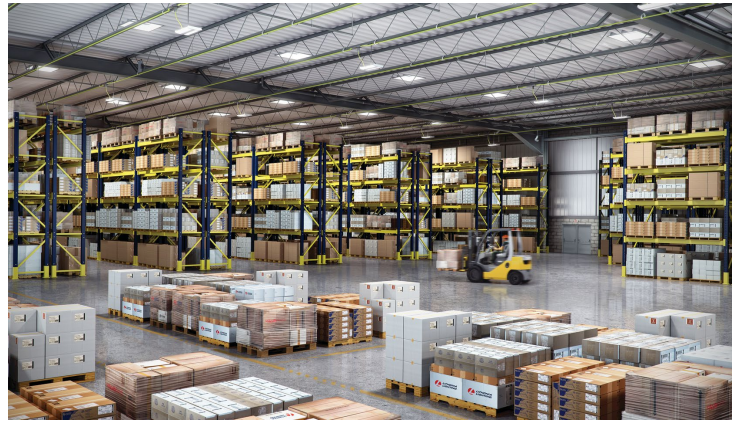
…and safety impacts

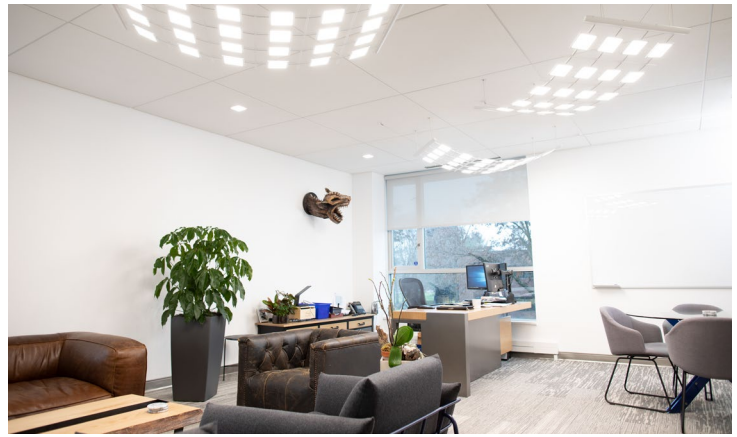
…and productivity and quality impacts

Next-generation Lighting: Energy Savings, Better Experiences

High quality light

Intelligent controls

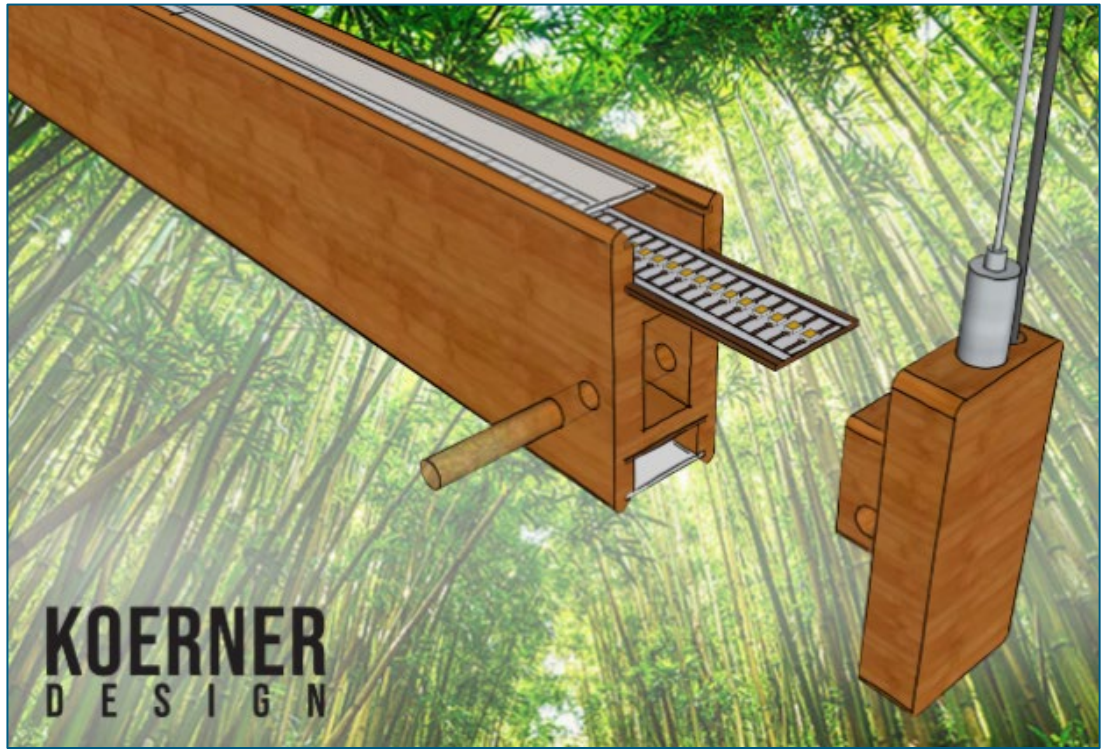


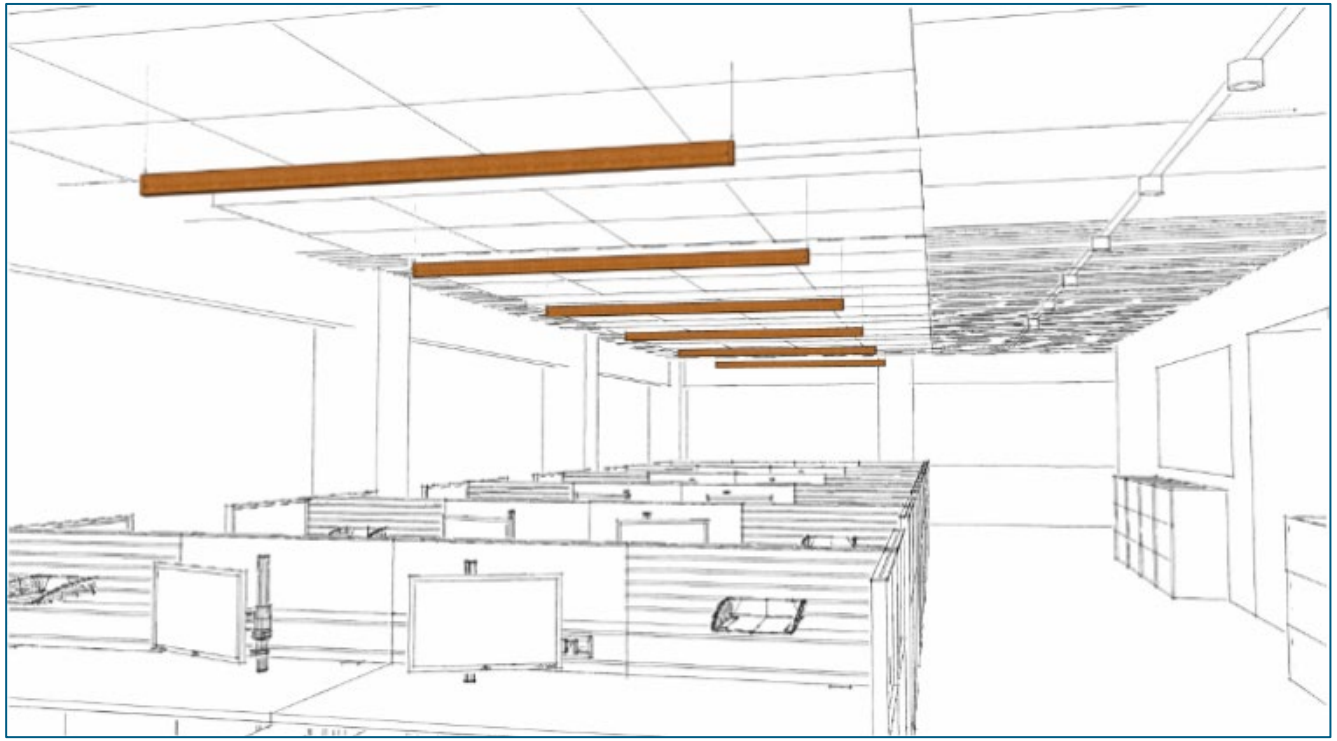


Feedback between technology and design

Photos (left and right top) courtesy of Lithonia Lighting. Photo (right bottom) courtesy of OLEDWorks.

New form factors and sustainable manufacturing





Bamboo pendant by Koerner Design: Winner of the DOE Manufacturing Innovator Challenge, Sustainable Manufacturing of Luminaires

New L Prize

Stay tuned!

Building decarbonization value proposition for the U.S. and the world

Build a stronger workforce and keep good jobs here

Help save the world!

Affordability for all

Improve the health and comfort of Americans while putting money back in taxpayer's pockets

Make a statement to our global partners that we are with them

Student Poster Competition: Honorable Mention

Nathan Eylands, Cornell University
Influence of Far-Red Intensity During the Seedling Stage on Photomorphogenic Characteristics in Leafy Greens

Rugved Kore, Penn State University
Color Characterization of an RGB Projector for Lighting Application Efficacy

Yi-Chia Tsai, University of Illinois, Urbana-Champaign
Next-Generation Green Light-Emitting Diodes by Novel Cubic III-Nitrides

Student Poster Competition: Grand Prize Winners

Ruqayah Bhuiyan, University of Georgia
Lettuce Tolerates Fluctuating Light, Potentially Reducing Energy Costs in Controlled Environment Agriculture

Yunping Huang, University of Washington
Green Syntheses of Stable and Efficient Organic Dyes for Organic Hybrid Light-Emitting Diodes

J. Mundinger, Penn State University
The Visual Experience of Fine Art Under Low Illuminance