U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Lighting R&D Workshop Welcome

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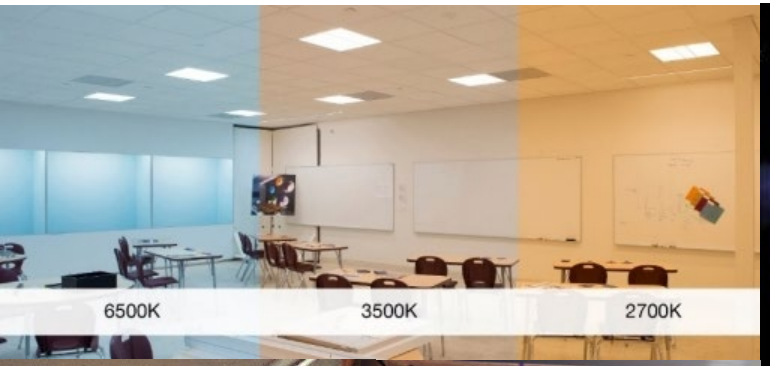
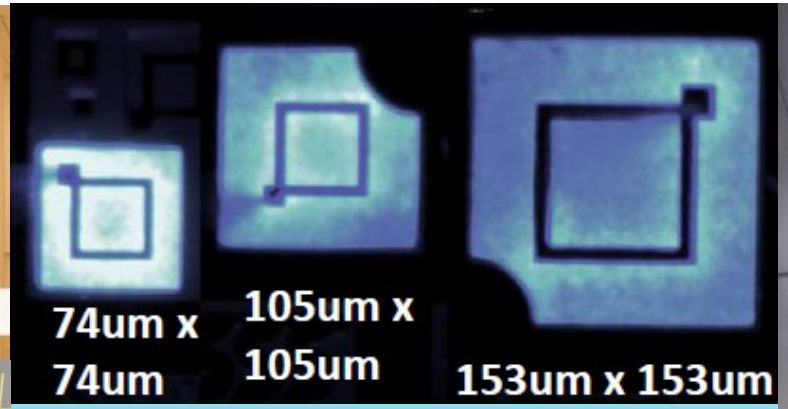
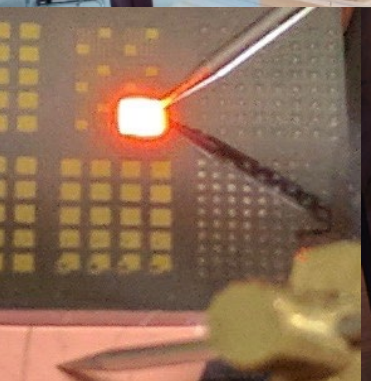
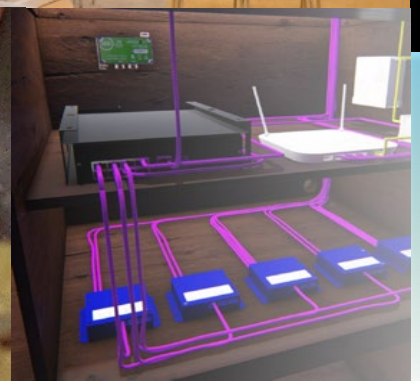
U.S. Department of Energy

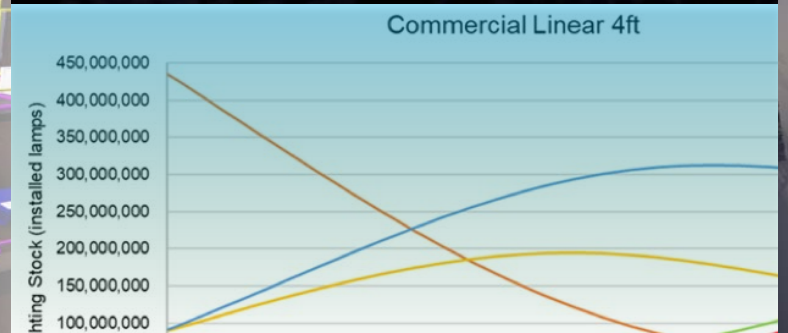
January 28, 2020

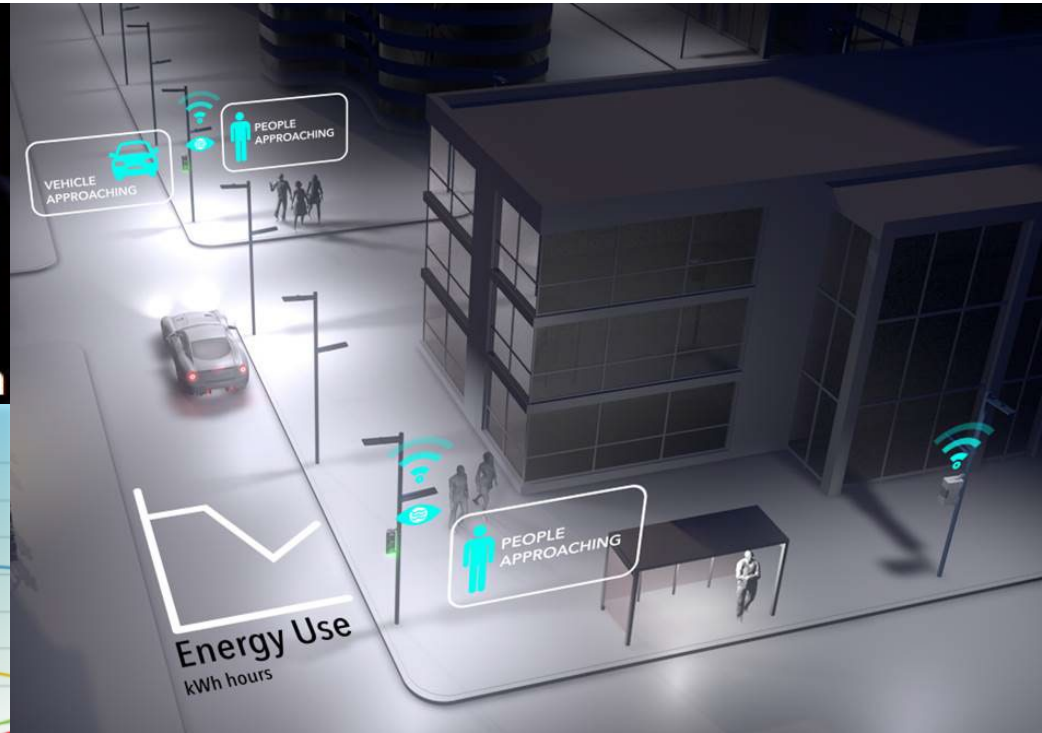






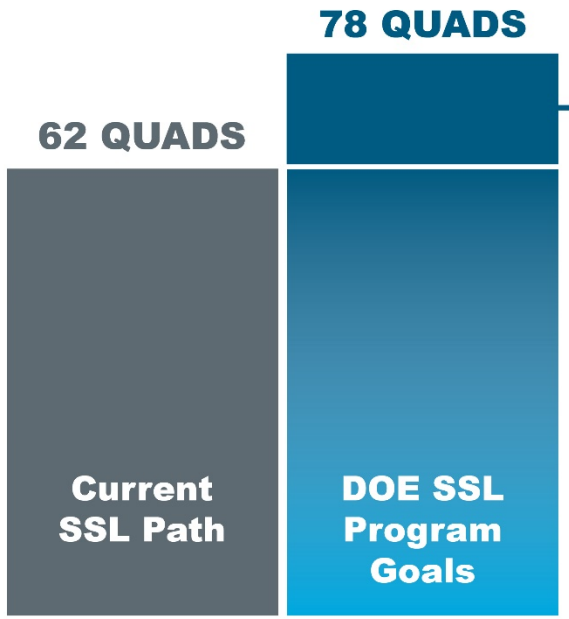






Turning Down Lighting Energy Usage

By 2035, LED lighting is expected to comprise 84% of all lighting installations, enabling **62 quads** of cumulative energy savings.

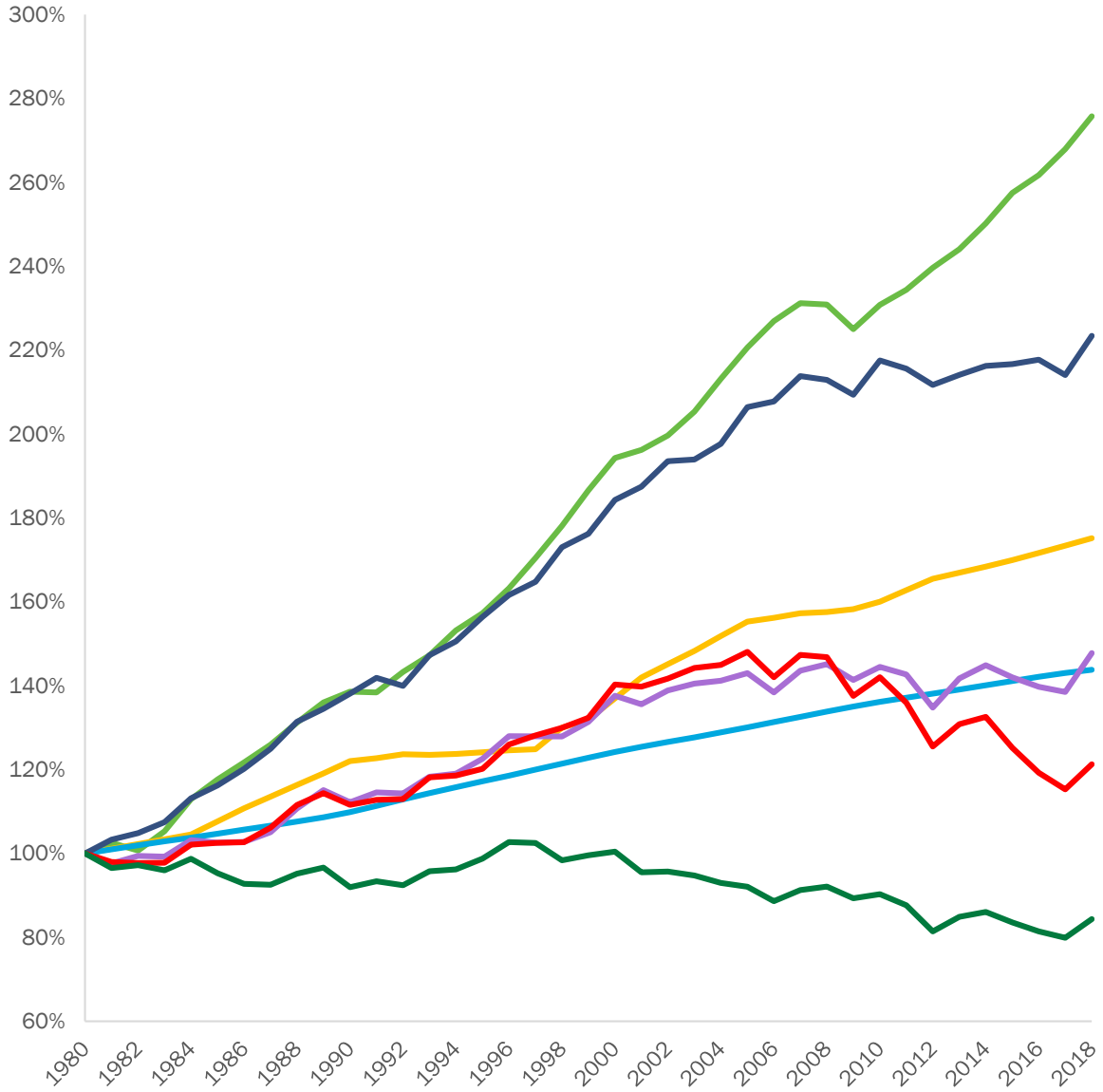


If DOE targets for efficiency and controls/ connected lighting are met, LEDs will enable an additional cumulative **16 quads** of energy savings through 2035.

The total cumulative energy savings of **78 quads** is equivalent to around **$890 billion** in avoided energy costs.

www.energy.gov/eere/ssl/ssl-forecast-report

Key Economic and Building Sector Trends



U.S. Gross Domestic Product (GDP)

U.S. Building Sector Electricity Use

U.S. Building Sector Floor Area

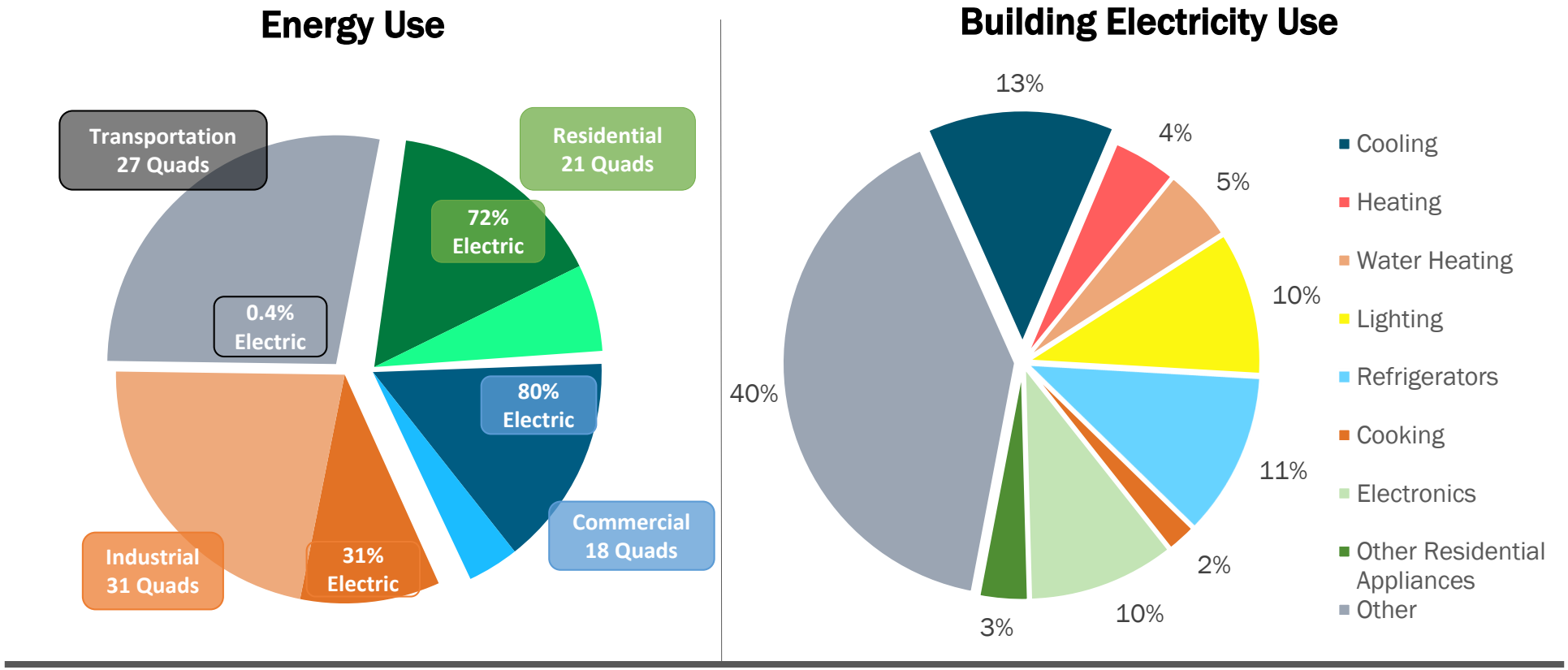
U.S. Building Sector Energy Consumption

U.S. Population

U.S. Building Sector CO_2 Emissions

U.S. Building Energy Use Intensity (EUI)

Energy use in the U.S. building sector



Buildings Energy Use: 40% of U.S. total

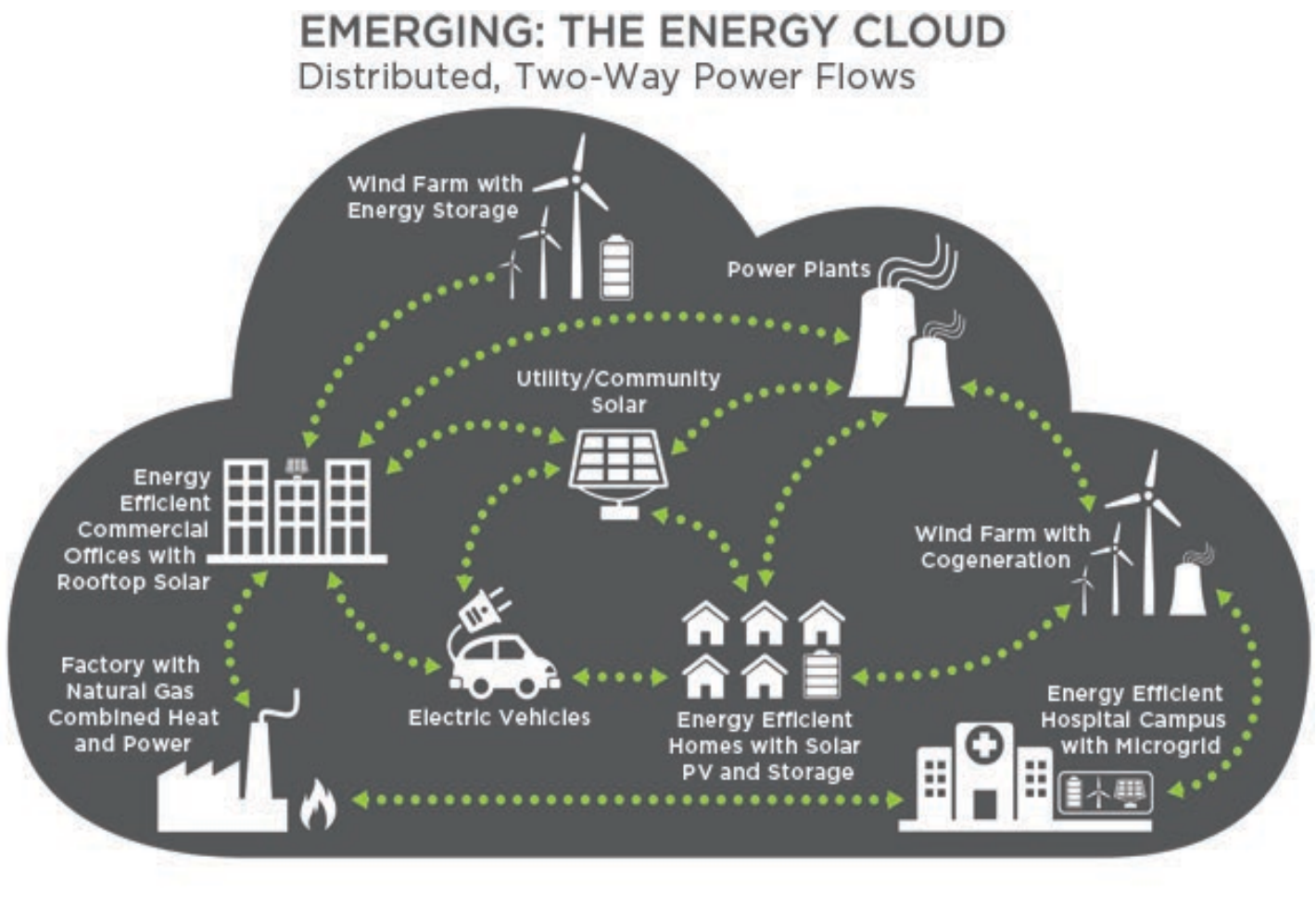
Buildings Electricity Consumption: 75% of U.S. total

Buildings Peak Electricity Demand: as much as 80% of regional total

Buildings CO_2 Emissions: 36% of U.S. total

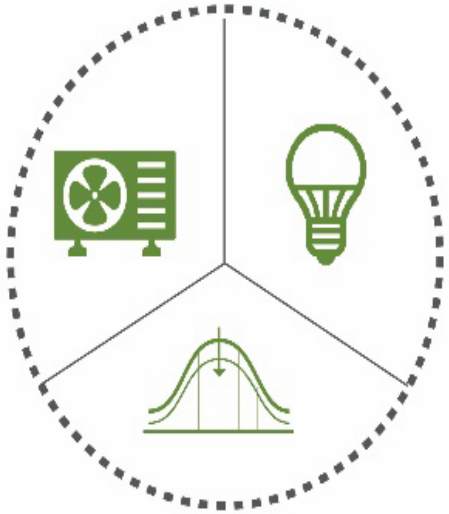
Buildings Energy Bill: $415 billion per year

Moving toward the grid of the future



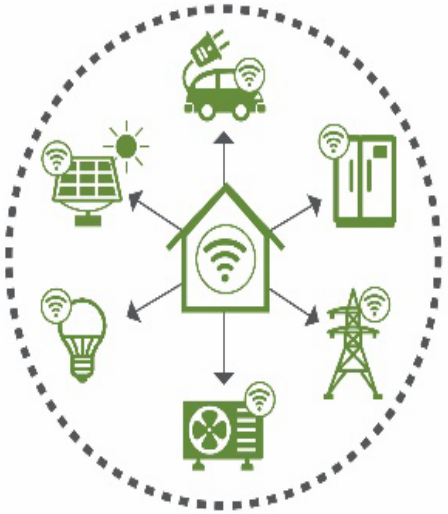
(Source: Navigant)

Characteristics of Grid-interactive Efficient Bldgs.



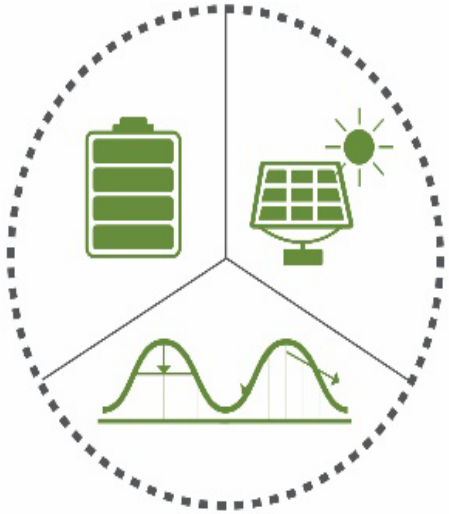
EFFICIENT

Persistent low energy use minimizes demand on grid resources and infrastructure



CONNECTED

Two-way communication with flexible technologies, the grid, and occupants



FLEXIBLE

Flexible loads and distributed generation/storage can be used to reduce, shift, or modulate energy use

SMART

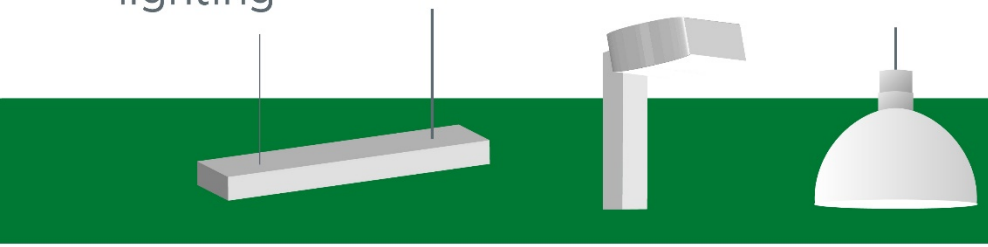
Computing, data analytics, and machine learning supported by sensors and controls co-optimize efficiency, flexibility, and occupant preferences

www.energy.gov/eere/buildings/GEB

Future Energy Savings Driven by Commercial Applications

Leading the charge: Commercial buildings

Most of the savings will be driven by linear fixtures, outdoor, and low and high bay lighting



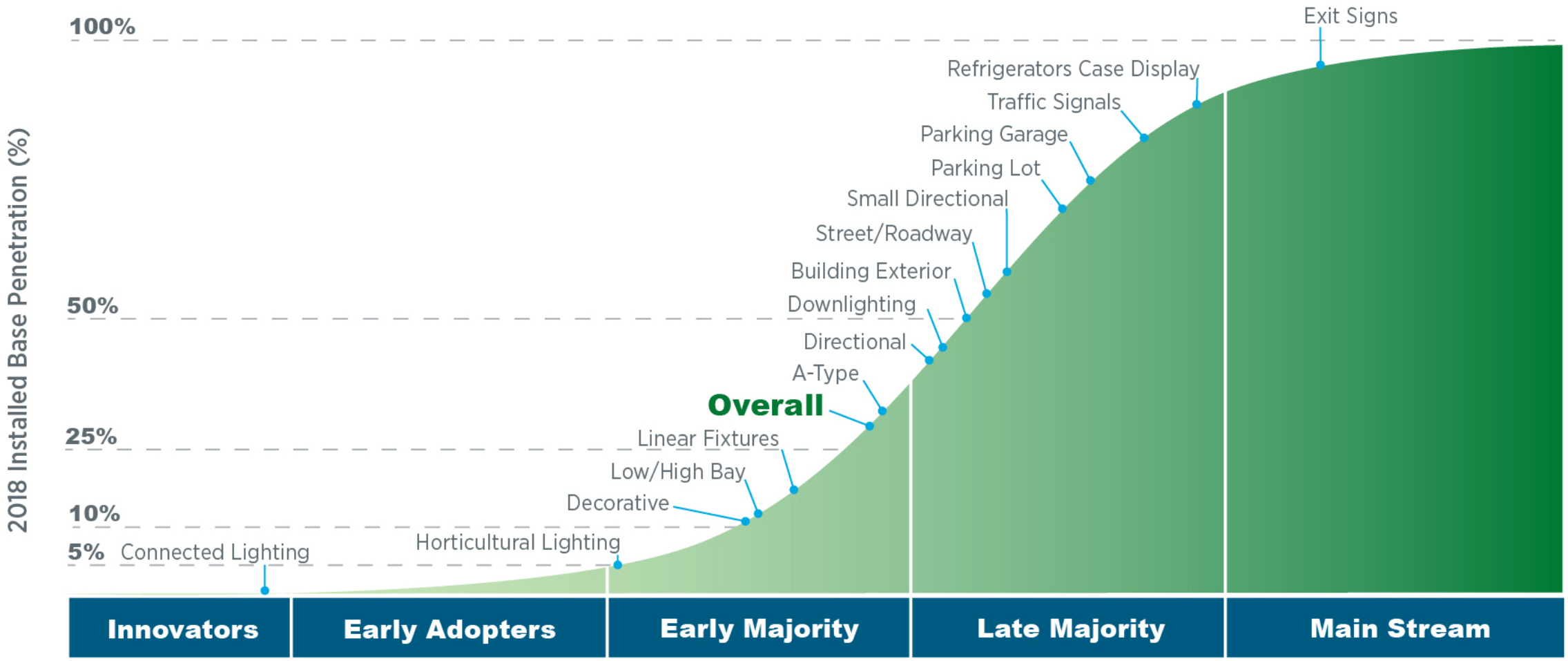
...applications with **high light output** and **long operating hours**

...where **controllability** and **networked capabilities** have the greatest value

	2017 Total Installations	2017 Energy Use	2035 SSL ENERGY USE: Current SSL Path	2035 SSL ENERGY USE: DOE SSL Program Goals
General Purpose	45%	11%	10%	13%
Directional	17%	7%	9%	10%
Decorative	17%	7%	5%	6%
Linear	14%	31%	37%	34%
Low/High Bay	1%	16%	14%	14%
Outdoor	<2%	24%	20%	20%
Other	3%	5%	3%	4%
TOTAL	7.6 Billion	5,970 tBTU	3,350 tBTU	2,040 tBTU

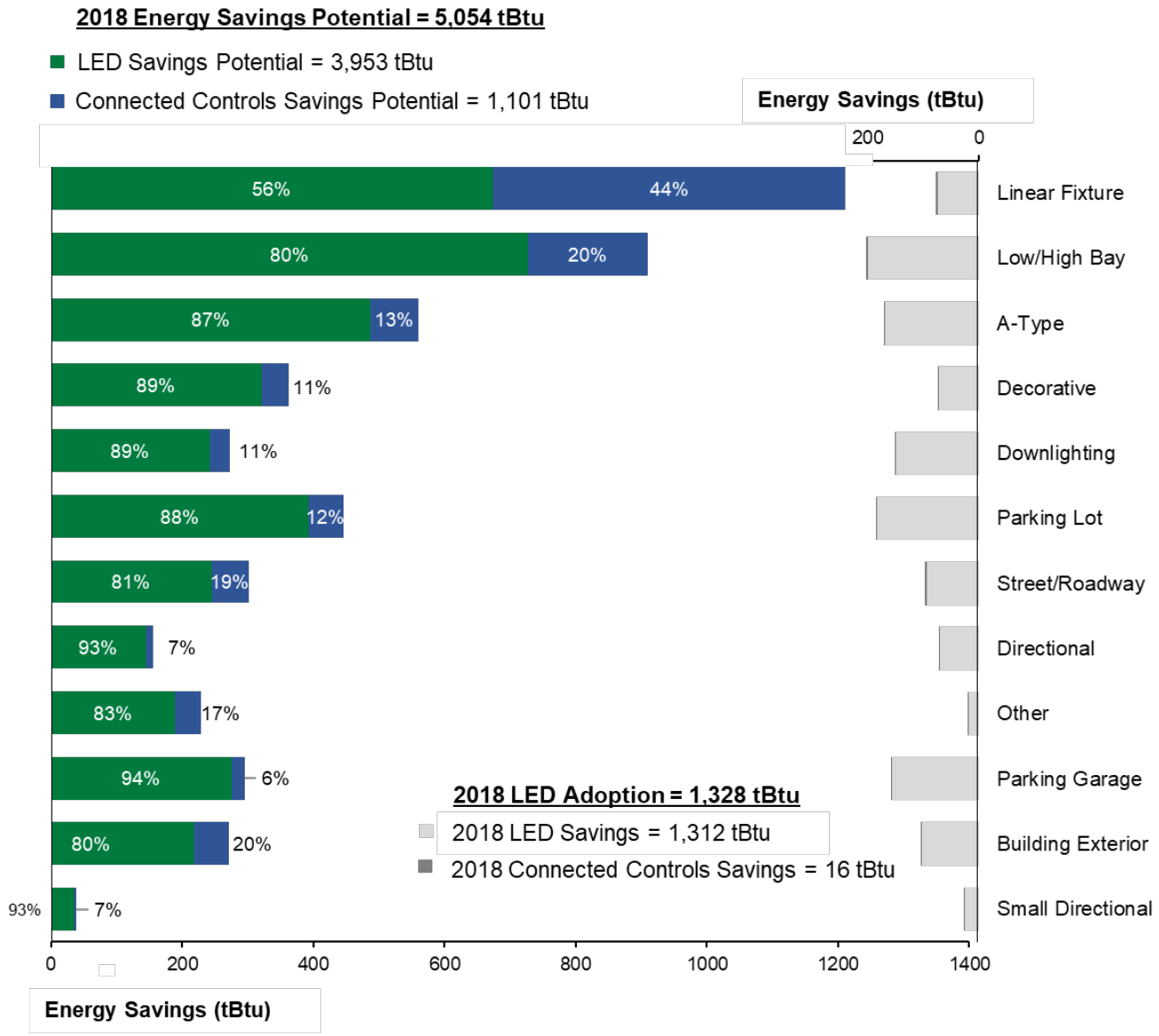
https://www.energy.gov/eere/ssl/ssl-forecast-report

Steady Growth in LED Lighting Adoption



The adoption of LED lighting is reaching the majority phase of product adoption, with most of the applications clustered in the “early majority” and “late majority” phases

Strong Energy Savings Potential

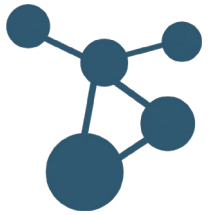


Low/High Bay, Parking Lot & Garage, and A-Type LED products currently save the most energy

Yet if paired with the overnight savings potential (95th percentile efficacy and 100% connected controls adoption), Linear Fixtures offer the highest savings potential

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

Results-Driven Program



322
Projects

316
Patents

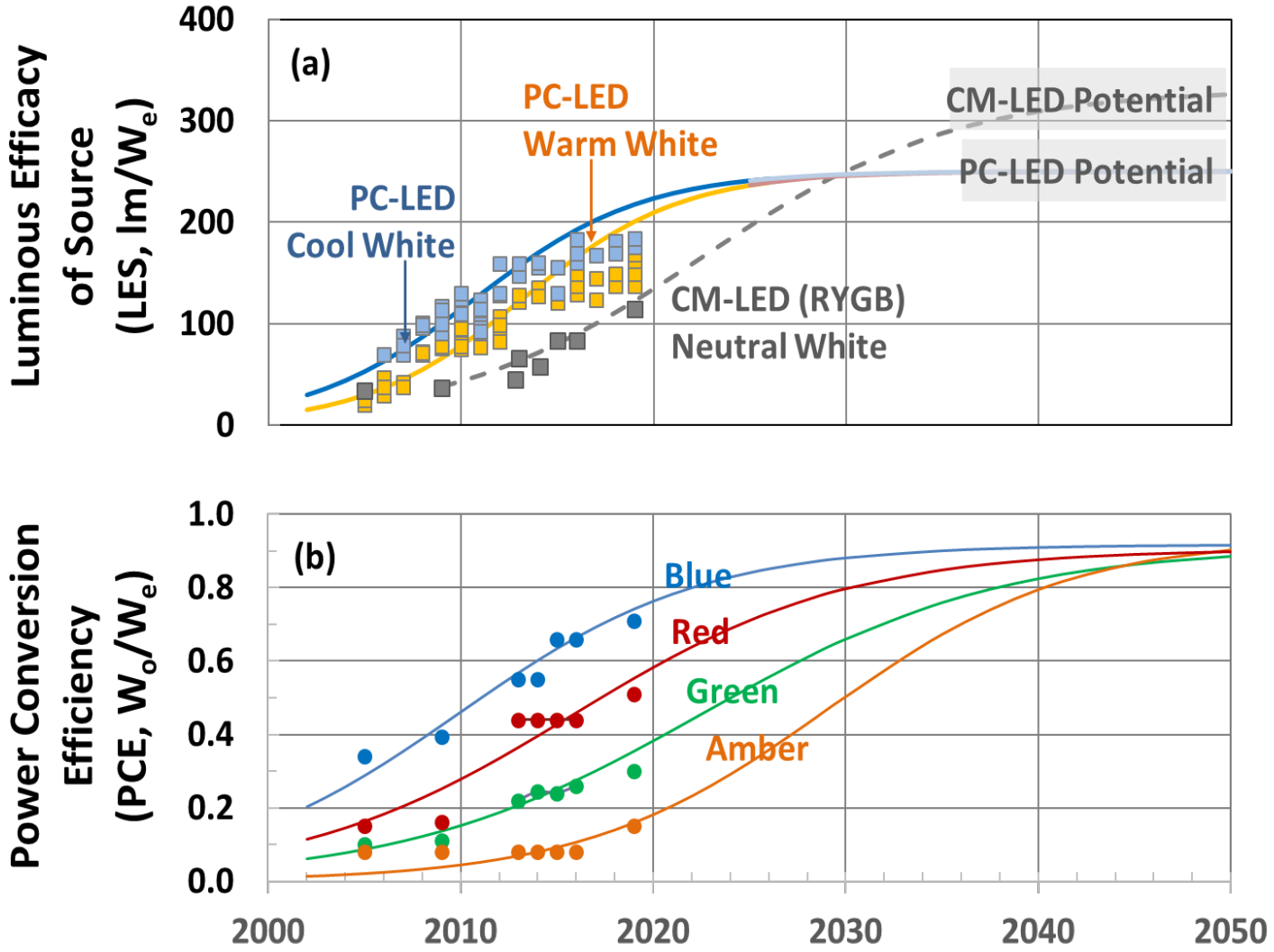
286
Products

1110
tBTU

10
Billion

www.energy.gov/eere/ssl/solid-state-lighting

2019 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

Broad Mix of R&D Partners

SSL Portfolio

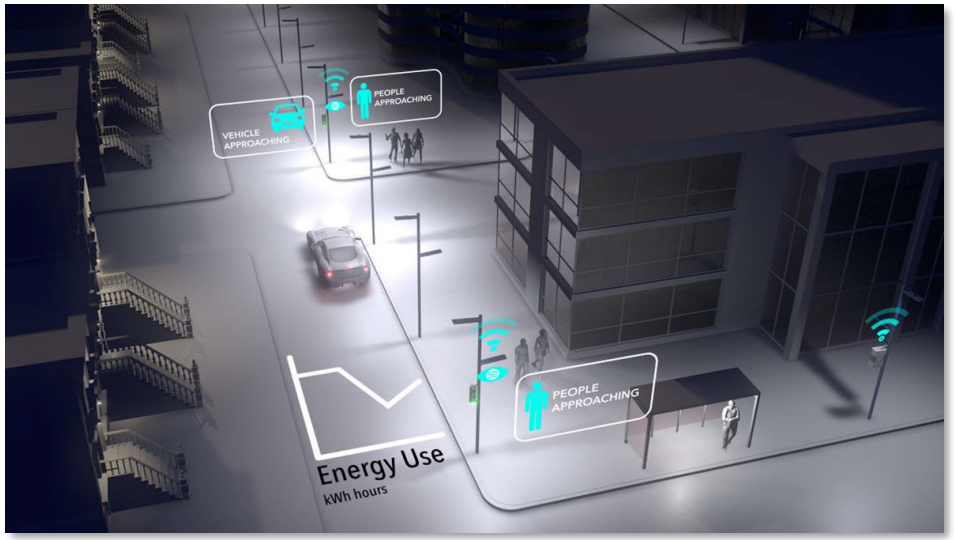
- ✓ SSL Funding Opportunity Announcement (FOA)
- ✓ Core and Competitive National Laboratory Calls
- ✓ Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) Grants
- ✓ Field Validation
- ✓ Technology Commercialization Fund

New Program Directions

- ✓ R&D challenges for lighting
- ✓ Emerging applications: Driven by specific needs
- ✓ Emerging metrics: Analysis, value propositions
- ✓ New partnerships
- ✓ Technology integration: Interoperability, daylighting
- ✓ Field validation: Testing, new environments

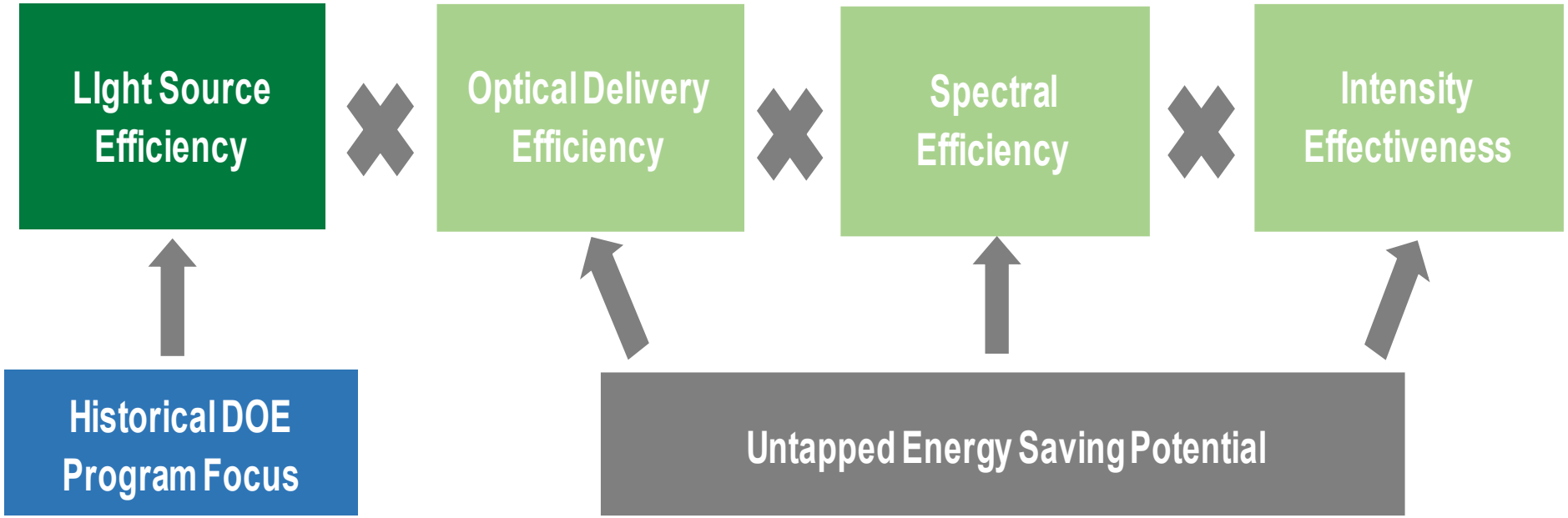
Changing Environment and Challenges

- **New capabilities of SSL coupled with new understanding in lighting science open up possibilities to:**
  - Further reduce lighting energy consumption
  - Improve lighting performance in new ways
  - Reduce negative impacts of earlier lighting technologies
- **More research is needed to expand our understanding of lighting application efficiency, visual and non-visual responses to light, connected lighting systems**



Lighting Application Efficiency

- Further energy savings can be achieved through improved optical control, spectral tailoring, and more precise control of intensity
- A new framework for modeling and evaluating trade-offs between factors is needed



Partnerships: Catalysts for Innovation

- Partners heavily involved in program planning
- Open information and process: Continual engagement, workshops, working groups
- Key partnerships support program activities: IES, NGLIA, IALD
- Collaboration with other Federal agencies: NIH, NSF, NIST, NPS, USDA, NIOSH, NASA, DOT, DOD, FCC, and more

Illuminating ENGINEERING SOCIETY

IALD

NGLIA
NEXT GENERATION LIGHTING INDUSTRY ALLIANCE

Technology Integration Collaborations

- **PNNL/LBNL daylighting collaboration**
  - Radiance modeling, spectral analysis
  - New, harmonized metrics for daylighting and electric lighting
- **Multi-lab interoperability effort**
  - PNNL, NREL, LBNL, ORNL, NIST
  - Evaluate interoperability across platforms

Field Validations: Testing, New Environments

- **Current knowledge is limited regarding emerging applications**
- **More research is needed to:**
  - Understand and properly control human responses to lighting in real-world settings
  - Understand the relationship between energy savings and wellness implications
  - Document the impact of LED streetlights on sky glow and energy use
  - Optimize agricultural lighting to achieve the desired benefits with minimized energy use
  - Understand new, far-field applications

Validation Activities

- **RTI International: Reliability testing for OLED panels and luminaires, LED drivers, multisource LED products**
- **NIST: Measurement science, testing and standards support, source characterization, color quality research**
- **OLED Testing: Collaborative R&D framework accelerates OLED technology advances**
  - Quicker turnaround for funding vs. FOAs
  - Less daunting application
  - Rapid results
  - Opportunity to collaborate with panel manufacturers

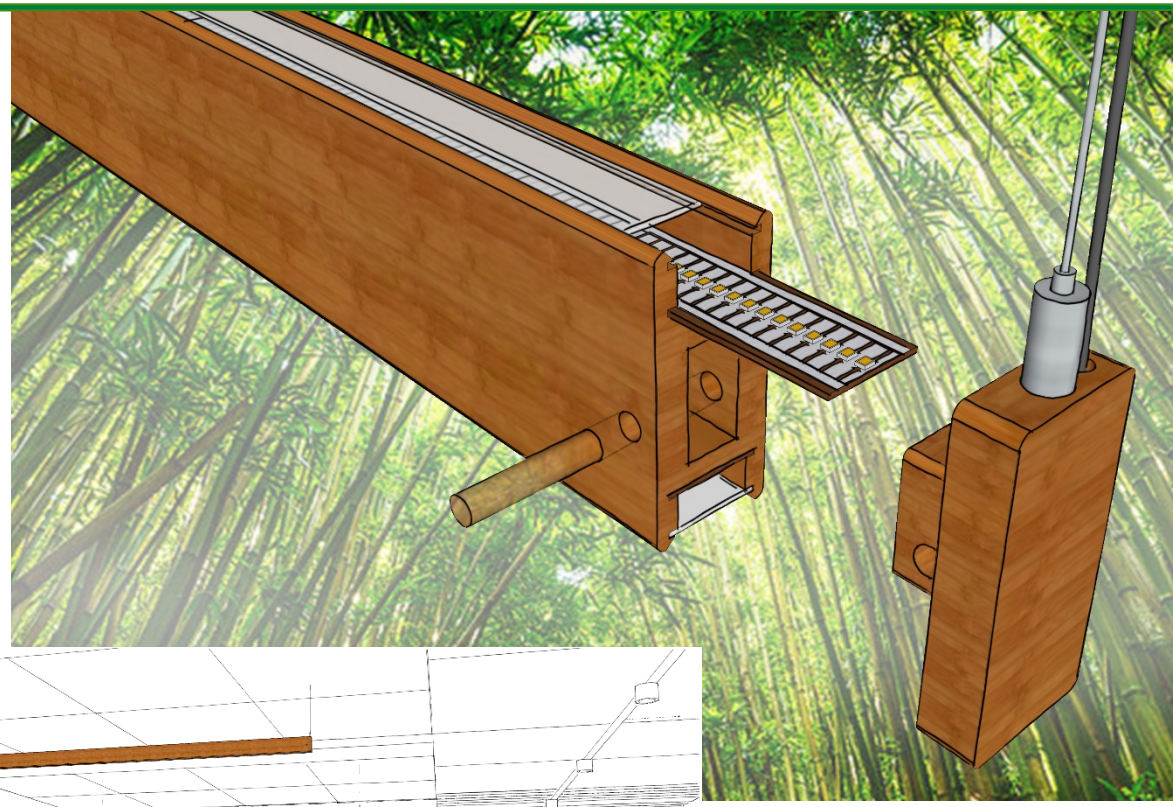
Manufacturing Innovator Challenge

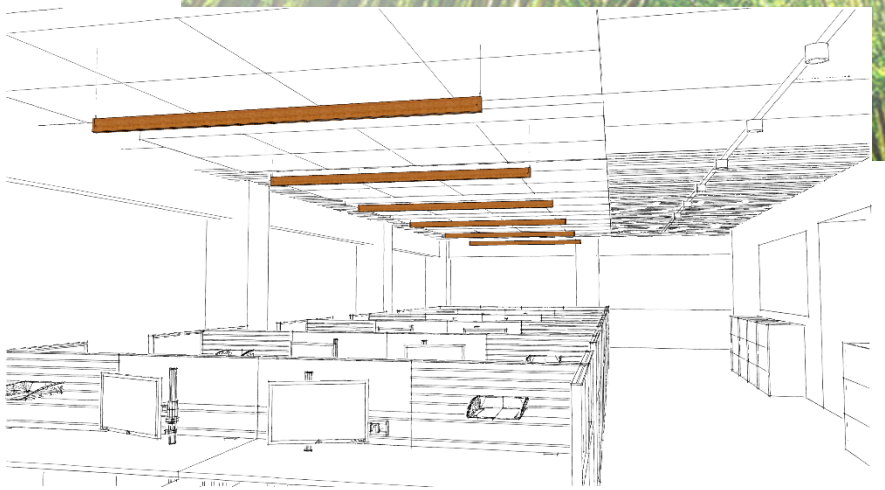
Congratulations to the winner of the Sustainable Manufacturing of Luminaires Challenge

BAMBOO PENDANT

Brad Koerner, Koerner Design

Design incorporates bio-derived and biodegradable, low-toxicity, sustainable materials





Student Poster Competition Winners

Congratulations to the winners of the 2020 student competition:

Syed Ahmed Al Muyeed, Lehigh University

Controlled Growth of Self-Assembled InGaN Quantum Dots Using Templates of Quantum-Size-Controlled Photo-Electrochemical Etched Quantum Dots

A.P. Sachintha G. De Vas Gunawardena, Rensselaer Polytechnic Institute

The Impact of Output Capacitor Aging Under Constant and Cycled Temperature Conditions on LED Driver Lifetime

Your Input Matters: Lighting R&D Workshop

- **2020 Workshop co-sponsored by DOE and IES**
- **Expanded format with 3 tracks**
  - Materials Research & Product Innovation
  - Lighting Science
  - Lighting Systems & Building Integration
- **70 expert speakers**
- **60 expert poster presenters**
- **Countless opportunities for discussion and input**