A New Tool for Meta-Analysis of Lighting Data and Projections

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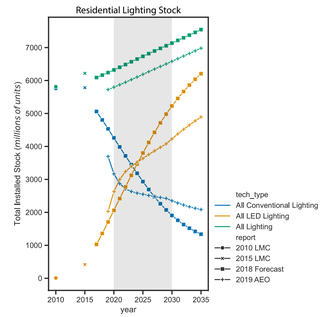
Motivation and Overview

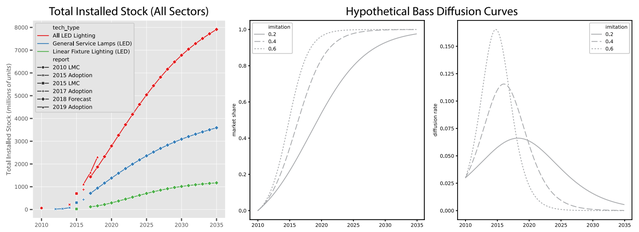
Solid-state lighting (SSL) has transitioned from a newly commercialized technology entering the market over the last decade to a mainstream lighting technology poised to surpass conventional lighting installations in the next decade and provide substantial energy and use-case benefits.

What metrics best describe this transition? What does the future hold for SSL? A number of reports have addressed questions of this sort and generated a wealth of real-world and modeled data pursuing answers.

We demonstrate a new program that aggregates and visualizes lighting data with user-specified constraints and preferences. Over 6000 data points from twenty technical reports capture trends and projections for a large variety of technologies, metrics, and sectors in a single graphical interface with four plot dimensions.

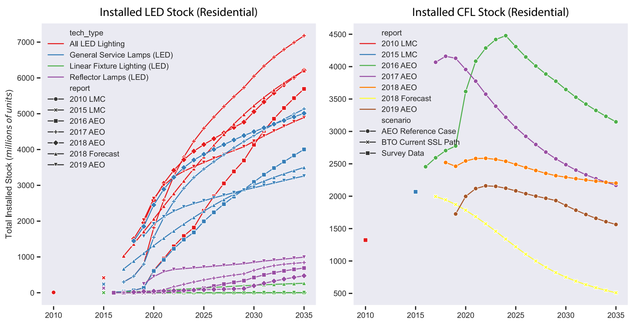


Diffusion and Confusion

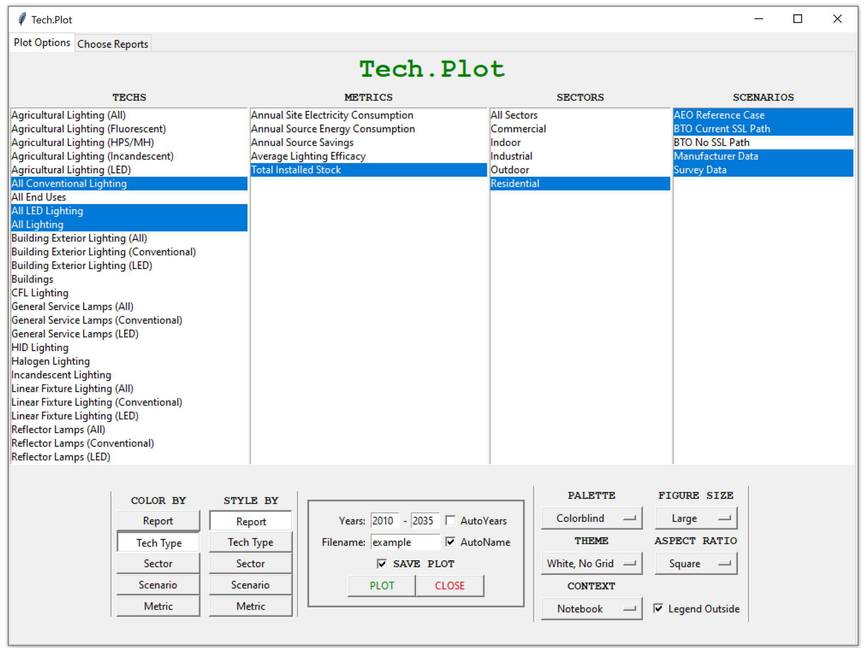


The Bass model for innovation diffusion predicts market penetration of new technologies as governed by internal (innovators) and external (imitators) influences on consumer adoption. The model has been widely employed to capture the S-curve character observed for market penetration of many consumer durables.

How do we determine if we are observing Bass-like technology diffusion for LEDs, and how do we parameterize the innovator and and imitator coefficients to adequately describe the market and make sound predictions?



Interface



Reports

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

The six US Department of Energy reports listed below constitute the majority of the data the program draws on to date. Additional reports from national laboratories, academia, and industry are in the process of being incorporated as well.

Reports are easily added as `.csv` files the program reads in at start up. The user can then toggle which reports to draw data from in the "Choose Reports" tab on the interface.

eia

SSL Forecast Report
Building Technologies Office
Model Data
2018

SSL Adoption Report
Building Technologies Office
Model and Manufacturer Data
2015, 2017, 2019

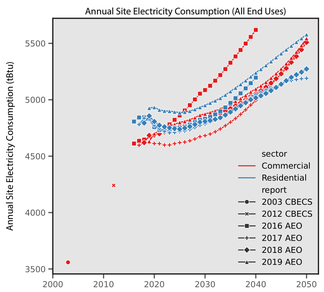
Lighting Market Characterization
Building Technologies Office
Survey Data
2001, 2010, 2015

SSL In Agriculture
Building Technologies Office
Stakeholder Engagement Data
2017, 2020

Annual Energy Outlook
Energy Information Administration
Model Data
2016, 2017, 2018, 2019

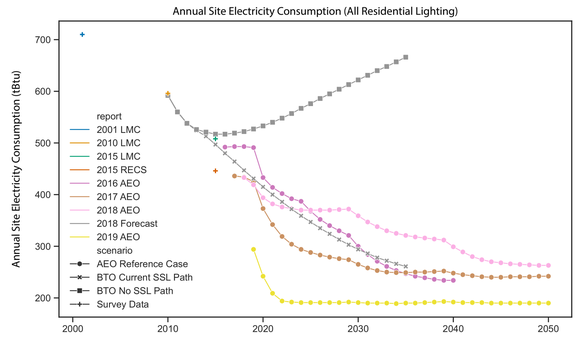
Commercial Energy Consumption Survey
Residential Energy Consumption Survey
Energy Information Administration
Survey Data
2003, 2012, 2015

Energy Consumption

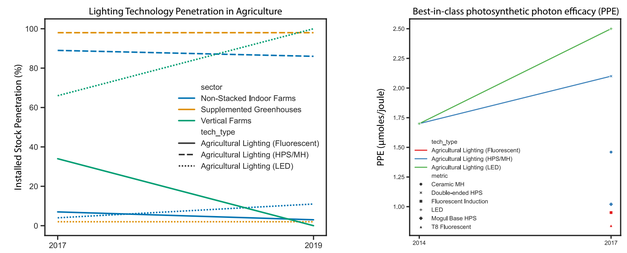


SSL and CFL adoption has driven steady and significant decline in lighting energy consumption despite increasing electricity consumption across all end uses. However, future projections for site electricity use vary, and suitable baselines for consumption are vital to assessing efficiency impacts in buildings.

Which model assumptions are most critical, and where projections differ, what can we learn about those assumptions? Which baseline should we use to calculate energy and emissions impacts of new efficiency measures?



Agricultural Lighting and Other Metrics



The program handles new and varying metrics easily, such that future reports on advanced, task-specific luminaire capabilities are readily incorporated. For instance, efficiency in agricultural settings is often better described in terms of how plants and animals respond to light than humans. We show from DOE Agriculture Reports data that LEDs now provide the best photosynthetic photon efficacy of any lighting technology. Vertical farms have switched almost entirely to LED use, while other horticultural farm types have been slower to adopt.