

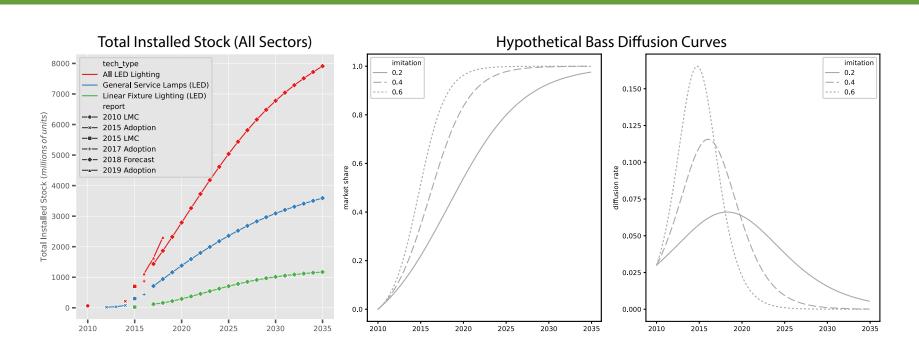
#### Motivation and Overview

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**



**Residential Lighting Stock** 

2010 2015 2020 2025 2030 2035

tech type

- All Lighting

report

•- 2010 LMC

--- 2018 Forecast

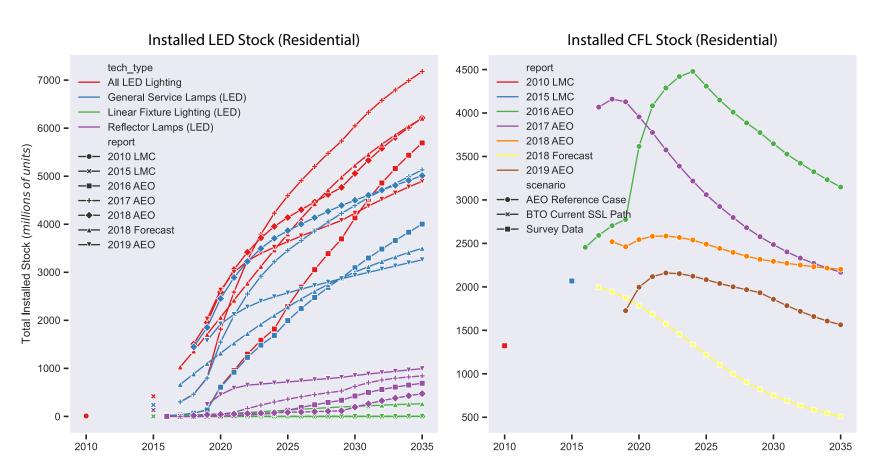
-+- 2019 AEO

- All LED Lighting

All Conventional Lighting

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?



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

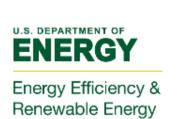
# WYATT G. MERRILL<sup> $\dagger$ </sup> AND BRIAN WALKER<sup> $\ddagger$ </sup>

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### Interface

🦸 Tech.Plot			- 🗆 X
Plot Options Choose Reports			
	Tech.P.	lot	
TECHS	METRICS	SECTORS	SCENARIOS
Agricultural Lighting (All)	Annual Site Electricity Consumption	All Sectors	AEO Reference Case
Agricultural Lighting (Fluorescent)	Annual Source Energy Consumption	Commercial	BTO Current SSL Path
Agricultural Lighting (HPS/MH)	Annual Source Savings	Indoor	BTO No SSL Path
Agricultural Lighting (Incandescent)	Average Lighting Efficacy	Industrial	Manufacturer Data
Agricultural Lighting (LED)	Total Installed Stock	Outdoor	Survey Data
All Conventional Lighting		Residential	
All End Uses			
All LED Lighting All Lighting			
Building Exterior Lighting (All)			
Building Exterior Lighting (Conventional)			
Building Exterior Lighting (LED)			
uildings			
FL Lighting			
General Service Lamps (All)			
eneral Service Lamps (Conventional)			
eneral Service Lamps (LED)			
HD Lighting			
Halogen Lighting			
ncandescent Lighting			
inear Fixture Lighting (All)			
inear Fixture Lighting (Conventional)			
inear Fixture Lighting (LED)			
Reflector Lamps (All)			
Reflector Lamps (Conventional)			
Reflector Lamps (LED)			
		,	1
COLOR BY	STYLE BY	PALETTE	FIGURE SIZE
Report	Report Years: 2010 - 2035	AutoYears Colorblind -	Large 💴
	Tech Type   Filename: example	AutoName THEME	ASPECT RATIO
Tech Type	reentype I Inchantes example		
	Sector SAVE PLOT	White, No Grid 🛁	Square 🛁
Tech Type			Square —

# Reports



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.



HC2.13 Lighting Usage Indicators by Type o Million U.S. Housing Units

Lighting Early Robinson 2014

CBECS

RECS

10 44 60 04 29 24 9 0 05 24 N N 00 21 N N 00 21 N N

Model Data 2018

Adoption Report I I I I I I I I I I I I I I I I I I I
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Survey Data

2001, 2010, 2015

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

SSL in Agriculture Building Technologies Office Stakeholder Engagement Data

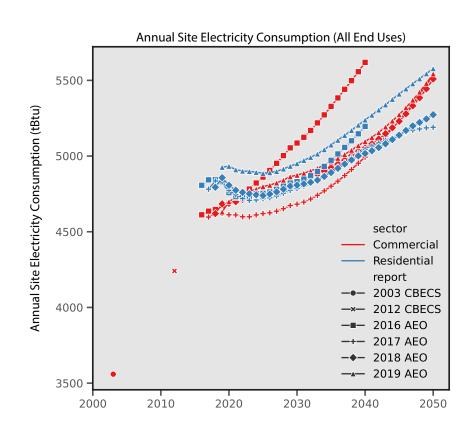
2017, 2020

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

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

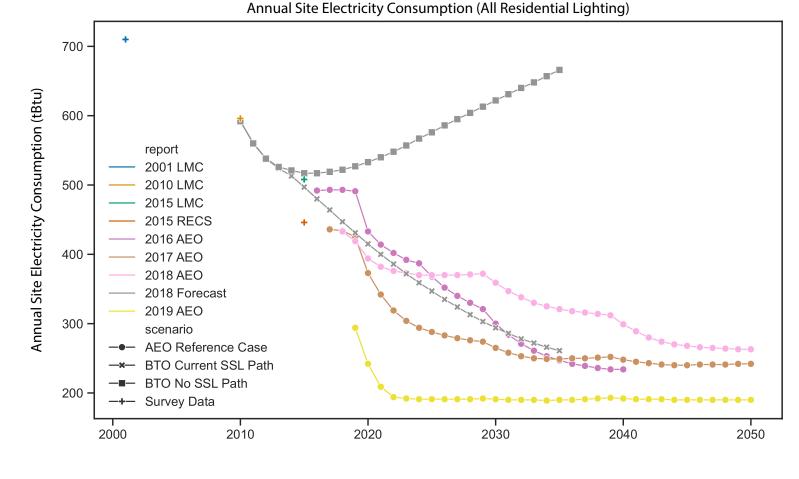


### **Energy Consumption**

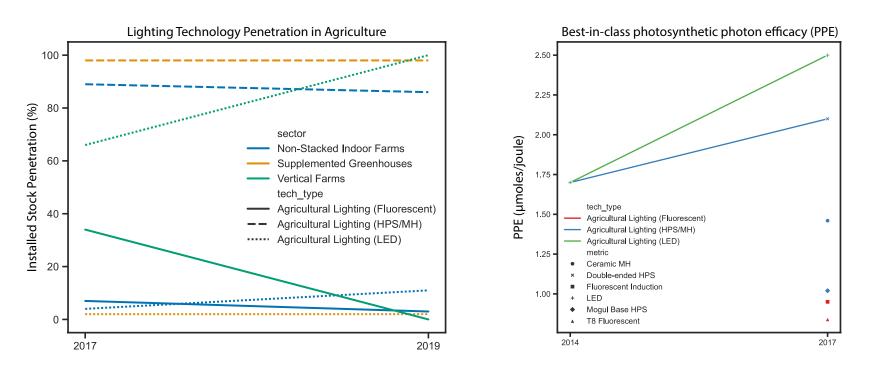


SSL and CFL adoption has driven steady and significant decline in lighting energy consumption despite increasing electricity consumption across all end uses. However, future projections for site electricity use vary, and suitable baselines for consumption are vital to assessing efficiency impacts in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