Comment:

The paper/document/article was on residential lightning prediction framework. Although it is of no direct usage, the framework can inspire variables, metrics, data processing and statistical assumptions. I have mentioned the different things we can replicate/use from this document.

Introduction:

The U.S. DOE Residential Lighting End-Use Consumption Study is an initiative of the U.S.

Department of Energy's (DOE's) Solid-State Lighting Program that aims to improve the understanding of lighting energy usage in residential dwellings. The study has developed a regional estimation framework within a national sample design that allows for the estimation of lamp usage and energy consumption 1) nationally and by region of the United States, 2) by certain household characteristics, 3) by location within the home, 4) by certain lamp characteristics, and 5) by certain categorical cross-classifications (e.g., by dwelling type AND lamp type or fixture type AND control type).

Important missing data handling technique:

For many regions, neither a local study nor direct reporting in a national survey was available for use in this analysis, so extrapolations were made based on the information known from neighboring or nearby regions. The available lighting inventory data available from the South census region were noticeably limited. Lighting inventory data averaged across all regions were assigned to homes in locations without regionally specific data.

Important statistics:

(1) The estimated daily usage per lamp averaged 1.6 hr for all lamps in the United States.

(2) Average estimated HOU per lamp were lowest in Missouri and Virginia (<1.5 hr per day) and highest in Massachusetts, New York, Texas, Oklahoma, Arkansas, and Louisiana (>1.6 hr per day).

(3) hallway lamps less than 1 hr par day, outer lamps for 3 hr par day, inside house higher consumption of hours.

Possible resources:

This study heavily leverages the recent California Residential Lighting Metering Study (CA RLMS) and U.S. Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS) datasets. The estimation framework is rooted in the 2009 RECS housing sample, and the analysis of covariance (ANCOVA) HOU models developed for the 2008-2009 CA RLMS were used to estimate lighting usage for each lamp type (e.g., incandescent, compact fluorescent light [CFL], or other type).

Possible visualization we can replicate:

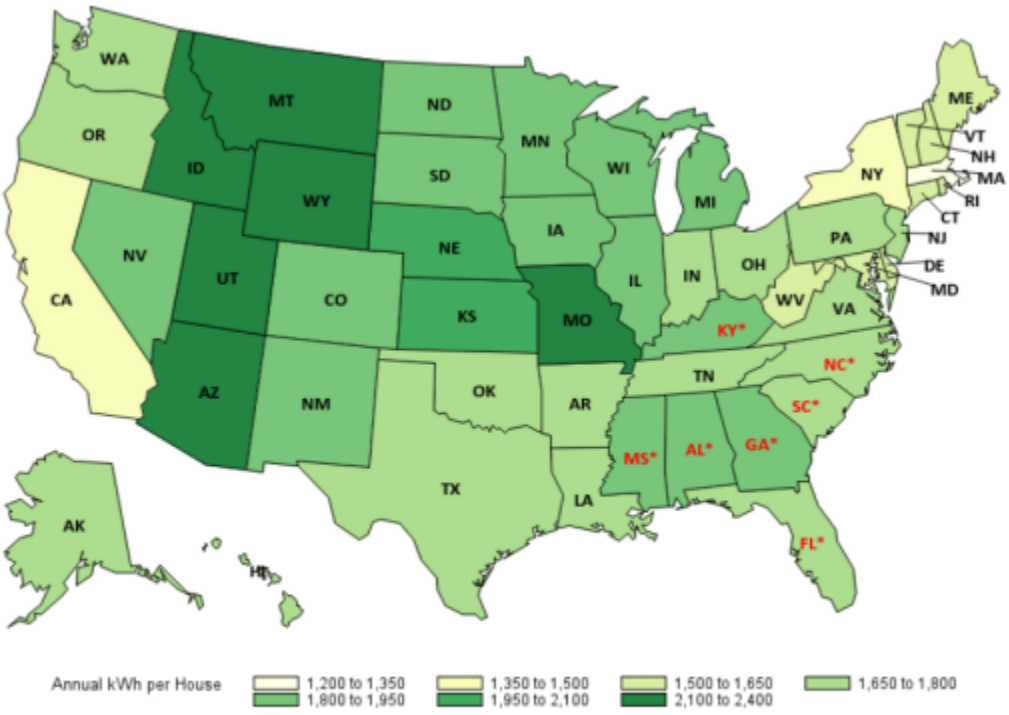

Figure ES.4. Regional Variation in Average Annual Lighting Energy Usage per Household

Lightning characteristics used:

Table 3.4. Lamp Characteristics in the Estimation Framework

Variable	Description	Valid Values
Location	The location of the lamp in the home	Fixture Storage
Socket Type ⇧	Socket used to install the lamp in a fixture	Screw-Base Pin-Base Other Base
Control Type ⇧	Control used to operate the lamp	On/Off control 3-way control Dimming control Other control
Lamp Type ⇧	Lighting technology used by the lamp	Incandescent CFL Other (e.g., LED)
Lamp Power ⊙	Rate of lamp energy consumption, in Watts	Numeric

⇧ Estimation Level ⊙ Estimated Lighting Measure

The different variables used in the framework:
The equivalent of these variables can be used in our model for commercial buildings.

Table 2.1. ANCOVA Model Variables Used in the CA RLMS

Variable	Description	Valid Responses
Bedrooms	Total number of bedrooms in the home	1 2 to 3 4+
Bathrooms	Total number of bathrooms in the home	1 2 3+
Composition	Presence of kids (0-17 years in age) in the household	Kids No Kids
Education Level	Highest education level of the household respondent	Less than High School High School Graduate College Post-Graduate
Lighting Space Type	Type of room or location, inside or outside of the home, where the lamp is located	Bedroom Bathroom Dining Room Living Room Kitchen Office Hall Entrance Garage Exterior Other
Fixture Type	Mounting location of the fixture housing the lamp	Ceiling Other
Number of Sockets	Total number of sockets in the home, whether occupied by a lamp or not	Numeric
Number of CFLs	Total number of installed CFLs in the home	1 to 2 3 to 4 5+
CFL Saturation	Total number of medium screw-base CFLs in the home (whether installed or in storage) divided by the total number of medium screw-base lamps in the home (whether installed or in storage)	Numeric
Investor-Owned Utility (IOU)	IOU that serves the household	Pacific Gas & Electric Southern California Edison San Diego Gas & Electric

A Hour of use prediction regression model:
Including this as this can inspire the type of regression model we may want to use.

Lamp HOU was estimated for each lamp type (incandescent, CFL, other) by multiplying the model coefficients by the corresponding covariates in the analysis dataset, and combining them according to the following equation:

$$\widehat{hou}_{raid} = \alpha_d + \beta_d composition_r + \gamma_d saturation_{ra} + \lambda_d spacetype_{rai} + \cdots + \varepsilon_{raid}$$

where
$\widehat{hou}_{raid}$ = Estimated lamp HOU
r = Estimation framework housing unit
a = Lighting space configuration
i = Inventory configuration
d = Day type (weekday or weekend/holiday)
$\alpha_d, \beta_d, \ldots$ = ANCOVA model coefficients for day type d
ε_{raid} = Model residuals[2]

ANCOVA coefficients for the CFL HOU model are available in the CA RLMS report.[3]