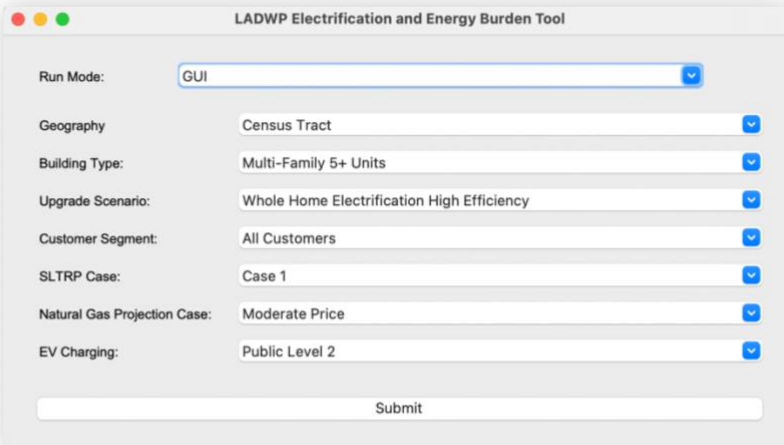
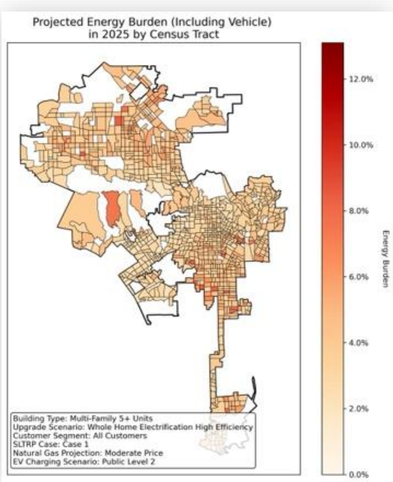
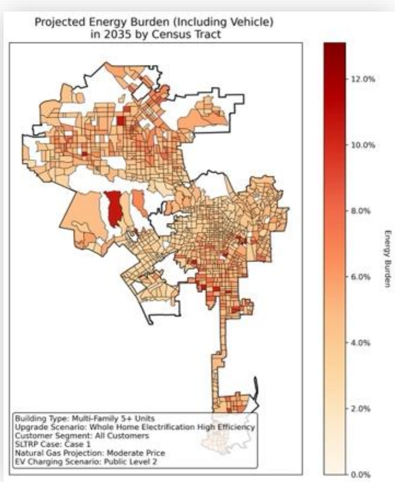
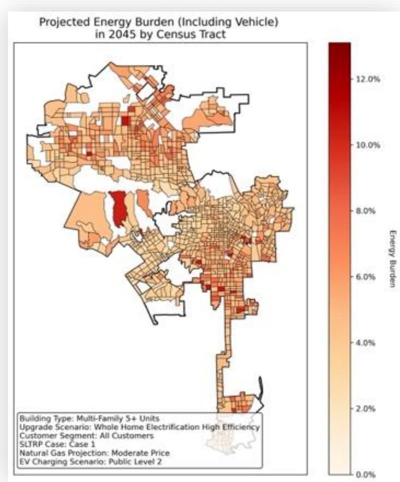
The Los Angeles Residential Energy Transition Tool Technical Handbook









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1. Introduction

The Los Angeles Residential Energy Transition Tool (LA RESET Tool) was developed by researchers at UCLA's California Center for Sustainable Communities (CCSC) and Luskin Center for Innovation (LCI) for LADWP's Integrated Resources Planning (IRP) Group.

The tool's primary application is analyzing potential energy burden impacts of rate changes and residential decarbonization across Los Angeles over the next two decades. Its outcomes are being integrated into the 2024 LA100 Plan, and it may be adapted in the future for analysis of alternative rate structures and new energy efficiency measures.

For the purposes of the tool and its analysis, *energy burden* is defined as the percentage of household income that is being allocated towards home electricity, natural gas, and vehicle fuel (whether that be gasoline or electricity) spending.

$$Energy\ Burden\ (\%) = \frac{Spending\ on{:}\ Home\ Electricity, Natural\ Gas, and\ Vehicle\ Fuel}{Household\ Income}$$

Energy affordability is a primary concern for energy and environmental justice advocates in Los Angeles, especially as the city assesses the revenue required to meet its 100% carbon-free by 2035 goals.

For LADWP, increasing revenue requirements will translate to higher electricity rates, which will in turn impact overall customer electricity bills. These impacts will be further complicated by changing energy consumption patterns as end-uses in buildings are decarbonized alongside generation, and appliances and vehicles are transitioned from fossil-fuel-based to electricity-based. It is important that the resulting changes in costs – including to electricity, natural gas, and vehicle fuel – be well understood as the city decides how to best reach LA's clean energy goals while supporting its most vulnerable residents.

We've developed this tool to provide a more granular picture of how the bills for different types of households across LA might be affected by changes in rates and end-use fuels.

Generally, the tool categorizes homes into five residence types: 1) Mobile Home, 2) Multi-Family 2-4 Units, 3) Multi-Family 5+ Units, 4) Single Family Attached, and 5) Single Family Detached. These categories reflect those used in both the U.S. Energy Information Administration's (EIA's) Residential Electricity Consumption Survey (RECS) and the National Renewable Energy Laboratory's (NREL's) building energy simulations.

In the tool, NREL's *ResStock* dataset, which includes simulated load profiles for each of these residence types before and after end-use electrification and efficiency upgrades, is combined with real consumption data from each of these types of units across LA. The ResStock building type options and upgrade scenarios can be found in Table 1.

The energy burden impacts of current and potential future vehicle electrification and solar photovoltaic systems are also included in the tool, along with granular behavioral data that paints a more detailed picture of consumption patterns.

Table 1. ResStock Building Types and Decarbonization Upgrade Scenario Options

Input	Options
Building Types	Mobile Home
	Multi-Family 2-4 Units
	Multi-Family 5+ Units
	Single Family Attached
	Single Family Detached
Upgrade Scenarios	Baseline
	Basic Enclosure
	Enhanced Enclosure
	Heat Pump Water Heaters
	Heat Pumps High Efficiency Electric Backup
	Heat Pumps Min Efficiency Electric Backup
	Heat Pumps Min Efficiency Existing Heating as Backup
	Whole Home Electrification High Efficiency
	Whole Home Electrification High Efficiency Plus Basic Enclosure Package
	Whole Home Electrification High Efficiency Plus Enhanced Enclosure Package
	Whole Home Electrification Min Efficiency

2. Conceptual Overview

2.1. How the Tool Works

2.1.1. Areas of Analysis

The tool is structured as a Python script with supporting CSV files of the key datasets needed to estimate energy burden over time in the City of Los Angeles. The tool enables users to evaluate future energy burden for Angelenos under different scenarios. The primary variables for assessment are differing energy rate projections (SLTRP cases; natural gas rates), as well as different building types and level of building retrofit and electrification (Table 1). Variables related to photovoltaic (PV) and electric vehicle (EV) adoption are also included.

The tool has two foundational data sources: NREL's *ResStock End Use Savings Shapes* dataset, which comes directly from NREL, and an *Energy Attributes* dataset, which was developed by UCLA and is a composite of many datasets representing energy-related behaviors and patterns across Los Angeles specifically. These data sources are complemented by current and projected data on electricity, natural gas, and gasoline pricing, as well as information on distributed energy resource (DER) and EV adoption across Los Angeles.

It would be ideal to estimate energy burden for each individual household across the city. However, this estimate is limited by the lack of publicly available household-level income data. Instead, the tool utilizes income data from the American Community Survey (ACS), a Census Bureau demographics survey. This income data is broken down by Census Tract and ZIP Code Tabulation Area (ZCTA).[1] Thus, the tool enables users to calculate energy burden at a variety of geographies as small as census tract. The four options for geography breakdown are: 1) Census Tract, 2) ZCTA, 3) Council District, and 4) Composite Disadvantaged Community (DAC) [2] Census Tracts vs. Composite Non-DAC Census Tracts.

Within these geographies, some assumptions are made to break down residents into even more discrete groups – including by building type (Mobile Home, Multi-Family 2-4 Units, Multi-Family 5+ Units, Single Family Attached, Single Family Detached) and program enrollment status (EZ-Save, California Alternate Rates for Electricity (CARE),[3] Lifeline, and net energy metering (NEM)). These assumptions, primarily related to income, are discussed further in the *Energy Attributes Dataset* subsection.

These more discrete groups (combinations of a specific geography, building type, and program enrollment status), referred to from hereon as "segments," are the building blocks of the tool (see **Figure 1**). Energy burden estimates and predictions are based primarily on the characteristics of these segments, combined with NREL's simulated building load changes after

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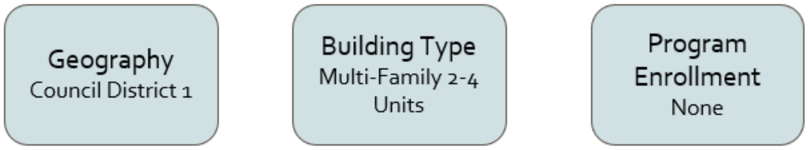
[1] ZCTAs are geographic areas roughly equivalent to U.S. postal ZIP Codes that are used for data tabulation in the U.S. Census. In the tool, ZCTAs are referenced and used essentially interchangeably with ZIP Codes.

[2] In the tool DACs are defined by the SB 535 CalEnviroScreen Data, as listed in the "SB 535 Excel Spreadsheet and data dictionary," found at https://oehha.ca.gov/calenviroscreen/sb535.

[3] https://www.socalgas.com/billing-payment/assistance-programs/california-alternate-rates-for-energy

electrification upgrades. More information on the segments' construction can also be found in the *Energy Attributes Dataset* subsection.

Figure 1. An LA RESET Tool "segment" represents a group of customers by geography, building type, and program enrollment.



2.1.2. Tool Logic

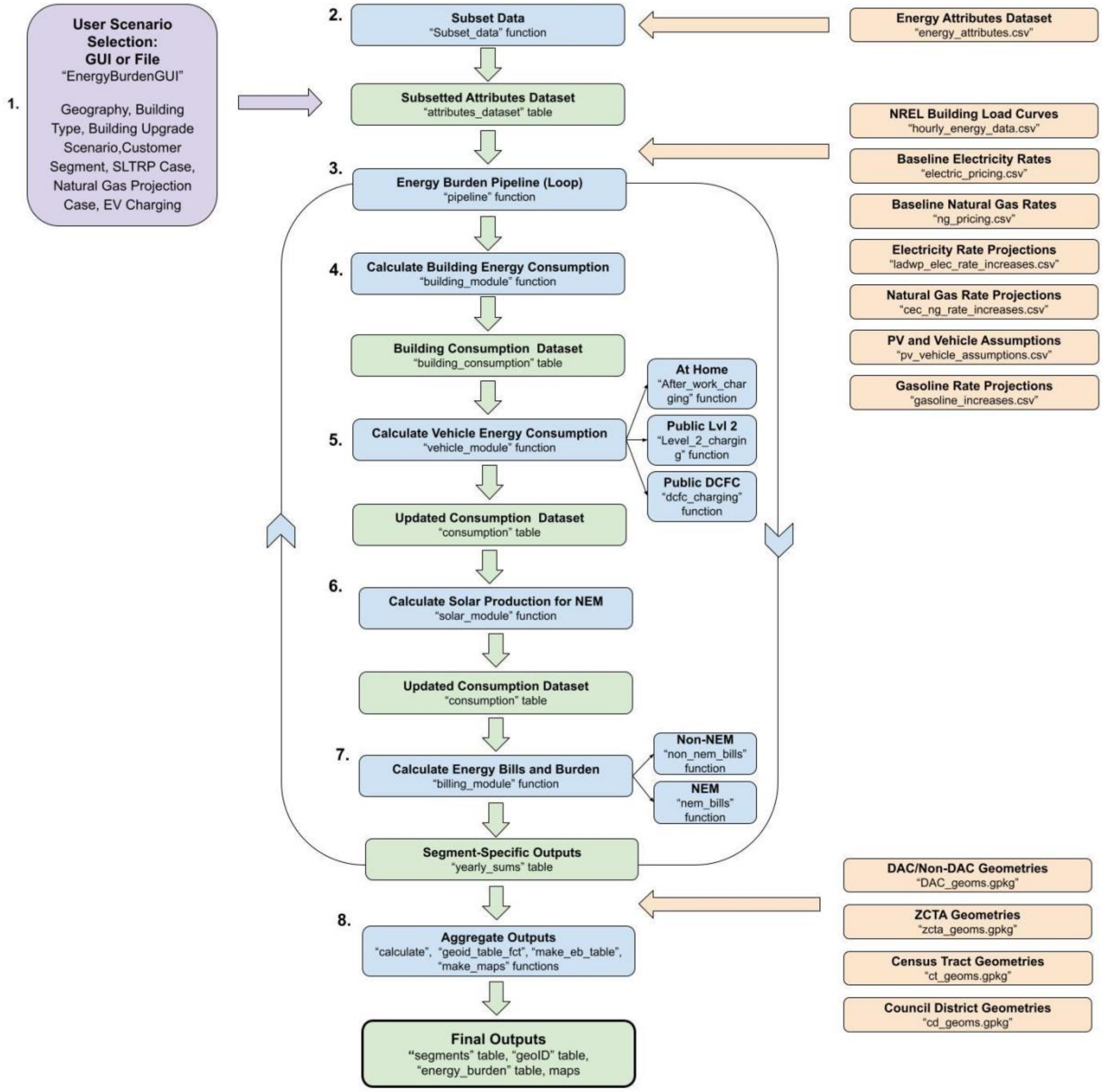
The tool's underlying script has several "modules" that are used to calculate energy burden by segment (and by geography-building type).[4] The tool starts off by (1) soliciting user inputs for geography, building type, upgrade scenario, and other characteristics with a graphical user interface (GUI). These inputs are then used to (2) select the corresponding subset of segments from the Energy Attributes dataset, which is imported. At this stage the other supporting files, including the NREL ResStock building load curves, energy pricing, vehicle characteristics, and energy projection datasets are also automatically imported. This new subsetted attributes segment is then (3) entered into a loop that calculates energy burden for each segment from 2024-2045. The first stage of this loop is (4) calculating building energy consumption based on the segment's characteristics and the user specifications. This produces a building consumption dataset that is then passed on to the next stage.

The next stage is (5) calculating vehicle energy consumption – in terms of gasoline for internal combustion engine (ICE) vehicle owners, and electricity for electric vehicle (EV) owners. The user selects one of three options for EV charging, which is then applied to all segments in the tool as a "charging scenario." These additional vehicle consumption patterns are added to the previous table and are passed back out as an updated consumption table.

The following stage is (6) calculating a possible solar output curve to amend NEM customers' consumption, which has been shared as net consumption. The additional curve is also added to the previous table and passed back out as an updated consumption table. The last step within the loop is (7) the calculation of electricity, natural gas, and gasoline bills by month and then by year. The results of this calculation are stored and passed out as a "yearly sums" table, and the loop restarts with the next segment from the attributes dataset.

[4] This just means that the segments representing different programs (EZ-Save, Lifeline, and non-assistance customers) can also be aggregated in the tool to produce representations of Energy Burden by geography and building type (e.g., all Council District 1 Multi-Family 2-4 Unit households). This is done using weighted averages by the number of premises in each segment.

Figure 2. LA RESET Tool logic structure, including modules, tables, and input datasets



Once all the segments have gone through the loop and every yearly energy burden (and associated spending and consumption) has been stored, the script exits the loop and the segment table is passed back out to be (8) aggregated in the final output functions. In order to generate the energy burden maps, the GeoPackage files including the geoid geometries are passed in. The tool run concludes with a set of final outputs, including three tables and maps of estimated energy burden in key years (2024, 2030, 2035, 2040, and 2045), all labeled with a "RunID" that represents the unique combination of user inputs.

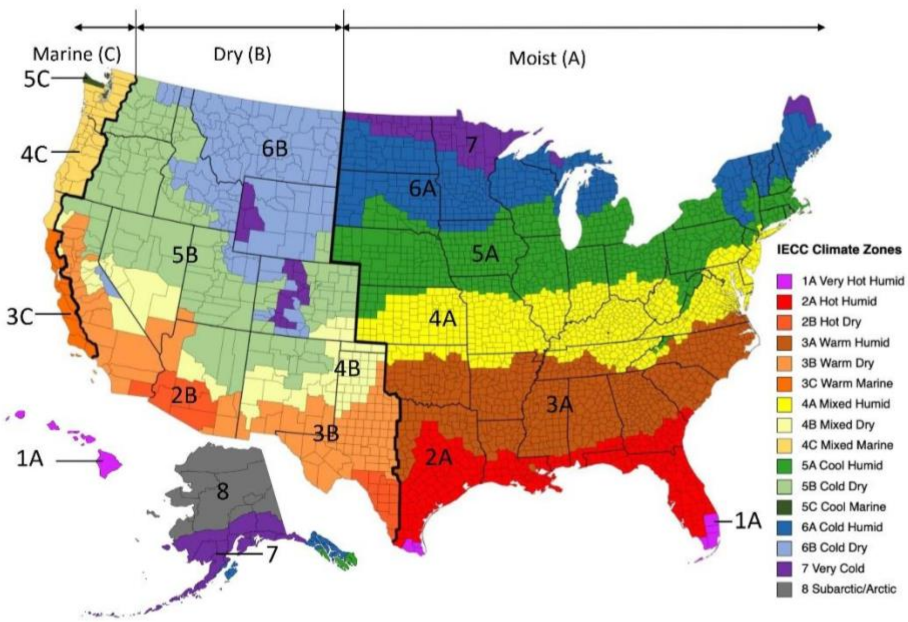
2.2. Primary Datasets

2.2.1. ResStock End-Use Savings Shapes

The LA RESET Tool uses NREL's ResStock End-Use Savings Shapes dataset to evaluate the impact of electrification on home energy usage. ResStock models load profiles across the U.S. (lower 48 and D.C.) housing stock and is used by governments, utilities, manufacturers, and real estate professionals.[5]

ResStock simulates each of the 16 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Climate Zones (see Figure 3). Los Angeles falls in Climate Zone 3B, Warm Dry climate. This climate zone also includes parts of the Central Valley, San Bernardino County, Arizona, New Mexico, and West Texas. To create more tailored-to-LA outcomes for the tool, we combine ResStock load profiles with real SoCalGas and LADWP energy consumption patterns from across the city; these are shared through the CCSC Energy Atlas. More details on these additional data sources can be found in the next section, *Energy Attributes Dataset*.

Figure 3. ASHRAE Climate Zones, as utilized by the ResStock dataset. Los Angeles falls into Climate Zone 3B, along with parts of the Central Valley, San Bernardino County, Arizona, New Mexico, and West Texas.



ResStock simulates energy use for each Climate Zone, and every simulation generates datasets for 11 efficiency and electrification scenarios for homes: one baseline and ten upgrade options. Because ResStock models five housing types, each simulation generates 55 datasets.

[5] https://www.nrel.gov/buildings/resstock.html

A single ResStock dataset, or load profile, represents a year of energy consumption, classified by end-use category (e.g. refrigerator, oven, washing machine and dryer, lighting, etc.).

These load profiles are contained in the End-Use Load Profiles (EULP) dataset,[6] from which the LA RESET Tool draws on what are called End-Use Savings Shapes (EUSS).[7] The tool uses EUSS data from 2022. EUSS contains 550,000 simulated load profiles, each of which represents an individual home.

To generate those load profiles, NREL started with 100 home characteristics (e.g. vintage, insulation, window type, and climate zone) based on probability distributions and then sampled those distributions to simulate 550,000 dwelling units.

Each simulated dwelling unit is a home that *could exist* somewhere in the U.S. The characteristics were drawn from EIA's Residential Energy Consumption Survey, and the Census's American Housing Survey and American Community Survey. The consumption patterns from these simulated dwelling units represent the **Baseline** scenario for the tool.

Energy consumption for a dwelling unit is broken into 15-minute intervals for one of three weather years: AMY 2018, AMY 2012, or TMY3.[8] The LA RESET Tool uses AMY 2018 weather data.

It's important to note that EUSS models dwelling units, not buildings. That is, while it models single-family homes and it models apartments, it does not model entire apartment buildings.

2.2.1.1. NREL's Electrification Scenarios

The EUSS data include 10 measure packages or electrification scenarios. Those packages are:

1. Basic Enclosure
2. Enhanced Enclosure
3. Heat Pumps, Min-Efficiency, Electric Backup
4. Heat Pumps, High Efficiency, Electric Backup
5. Heat Pumps, Min-Efficiency, Existing Heating as Backup
6. Heat Pump Water Heaters
7. Whole-Home Electrification, Min-Efficiency
8. Whole-Home Electrification, High Efficiency
9. Whole-Home Electrification, High Efficiency + Basic Enclosure Package
10. Whole-Home Electrification, High Efficiency + Enhanced Enclosure Package.

See below for a basic description of each package.[9]

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[6] https://www.nrel.gov/buildings/end-use-load-profiles.html

[7] https://oedi-data-lake.s3.amazonaws.com/nrel-pds-building-stock/end-use-load-profiles-for-us-building-stock/2022/EUSS_ResRound1_Technical_Documentation.pdf

[8] https://www.nrel.gov/buildings/assets/pdfs/euss-resround1-webinar.pdf#page=14

[9] Detailed descriptions of each package can be found here: https://oedi-data-lake.s3.amazonaws.com/nrel-pds-building-stock/end-use-load-profiles-for-us-building-stock/2022/EUSS_ResRound1_Technical_Documentation.pdf#page=4

The **Basic Enclosure** package includes no appliance upgrades and relatively basic insulation and sealing – including attic floor insulation, duct sealing, wall sealing, and wall insulation.

Similarly, the **Enhanced Enclosure** package also does not upgrade appliances, but it does improve insulation and sealing – including the above plus rim and joist insulation, as well as attic ceiling insulation.

Each home with the **Heat Pumps, Min-Efficiency, Electric Backup** package gets a heat pump. Dwelling units with ducts get a centrally ducted heat pump, and those without get a ductless mini split heat pump. Both heat pump options are considered "minimum efficiency." For both types of dwelling units, when the heat pump can't meet the load, electric resistance provides the backup heat.

The **Heat Pumps, High Efficiency, Electric Backup** package is the same as the previous package but uses high-efficiency heat pumps: centrally ducted *variable speed* for dwelling units with ducts and ductless *variable speed mini split* for those without.

Dwelling units with the **Heat Pumps, Min-Efficiency, Existing Heating as Backup** package is identical to the first min-efficiency heat pump scenario but with differences for the backup heating source. Units whose existing heating is non-electric fueled or electric-fueled and ductless retain the existing heating system as backup, while units with ducted electric heating in the baseline use electric resistance as backup.

For the **Heat Pump Water Heaters** package, homes with an existing water heater *other than an electric tankless water heater* receive a heat pump water heater (and no other upgrades).

The **Whole-Home Electrification, Min-Efficiency** package includes no enclosure measures (not even the basic enclosure package), but a host of minimum-efficiency appliance upgrades. These include: a heat pump, a heat pump water heater, an electric resistance dryer, and an electric range. Dwelling units that already have these electric appliances do not receive the upgrades.

The **Whole-Home Electrification, High Efficiency** package is identical to the previous package, but uses high-efficiency appliances, including: a heat pump water heater, a ventless heat pump dryer, and an electric oven and induction range. These are applied to all homes with no electric appliances or less efficient electric appliances.

The final two packages – **Whole-Home Electrification, High Efficiency + Basic Enclosure Package** and **Whole-Home Electrification, High Efficiency + Enhanced Enclosure Package** – differ only in terms of the enclosure package. The first one combines packages 1 and 8, the second packages 2 and 8.[10]

2.2.1.2. Preparing the ResStock Data for Use in the Tool

The ResStock data, aggregated and referenced in the tool as the "hourly_energy_data.csv" file, was originally downloaded from the U.S. Department of Energy's Open Energy Data Initiative

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[10] See here for a description of the data sources used to create the EUSS dataset: https://oedi-data-lake.s3.amazonaws.com/nrel-pds-building-stock/end-use-load-profiles-for-us-building-stock/2022/EUSS_ResRound1_Technical_Documentation.pdf#page=3

(OEDI) Data Lake.[11] This is where NREL has publicized the ResStock End Use Load Profiles for US Building Stock. The load profiles for each combination of building type and upgrade scenario, by ASHRAE climate zone, are stored by upgrade scenario (labeled upgrades 0-10).[12] To download the load profiles, which are each stored as individual CSVs, we had to navigate from upgrade scenario to climate zone 3B to building type, where all five building types were stored.[13] This was done 11 times, resulting in 55 CSVs, one for each upgrade scenario-building type combination.

These CSVs contain the aggregate end-use energy consumption for hundreds of thousands of modeled units for each upgrade scenario-building type combination. More specifically, they include energy consumption by end use for electricity, natural gas, and propane, as well as totals and emissions factors, for each of the 8760 hours in a year.[14]

To create simplified electricity and natural gas load curves for use in the tool, we utilize the total electricity and total natural gas consumption columns from the NREL datasets (columns AZ and BB), divided by the number of modeled units. For the whole home electrification scenarios, all gas consumption is zeroed out.

These total consumption load curves were then combined into one large spreadsheet, including a timestamp column and 2 columns for each building type-upgrade scenario combination – resulting in 111 columns in total.

2.2.2. Energy Attributes Dataset

The Energy Attributes Dataset – the LA RESET Tool's second foundational dataset – is a compilation of various energy-related characteristics across the different geographies of Los Angeles. Compiled by the researchers at UCLA, this dataset enables more accurate estimates of energy burden across the city both in 2024 and into the future. See Figure 4 for a general schematic of Energy Attributes data sources.

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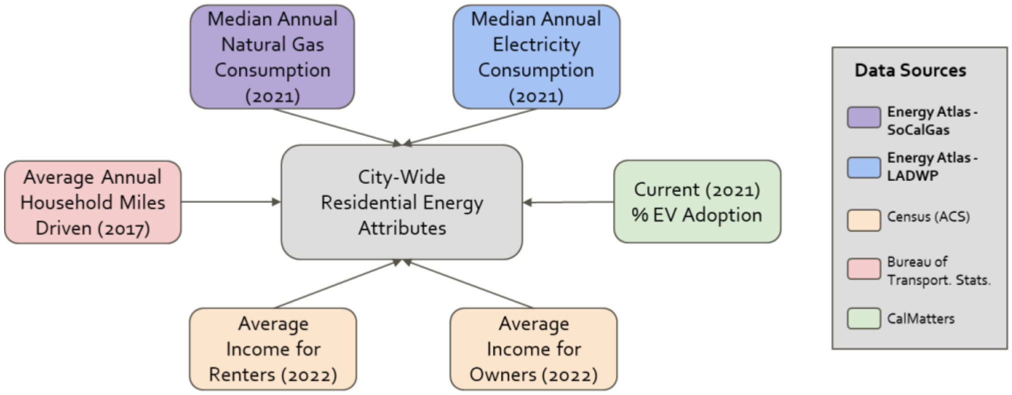
[11] https://data.openei.org/

[12] https://data.openei.org/s3_viewer?bucket=oedi-data-lake&prefix=nrel-pds-building-stock%2Fend-use-load-profiles-for-us-building-stock%2F2022%2Fresstock_amy2018_release_1.1%2Ftimeseries_aggregates%2Fby_ashrae_iecc_climate_zone_2004%2F

[13] For example, for the baseline scenario, labeled upgrade "0," https://data.openei.org/s3_viewer?bucket=oedi-data-lake&prefix=nrel-pds-building-stock%2Fend-use-load-profiles-for-us-building-stock%2F2022%2Fresstock_amy2018_release_1.1%2Ftimeseries_aggregates%2Fby_ashrae_iecc_climate_zone_2004%2Fupgrade%3D0%2Fashrae_iecc_climate_zone_2004%3D3B%2F.

[14] For an example of an original EUSS dataset for a Baseline Mobile Home, see Supporting Files, "up00-3b-mobile_home.csv."

Figure 4. Energy Attributes Dataset sources



2.2.2.1. Energy Atlas Data: LADWP Electricity consumption and SoCalGas Natural Gas Consumption

The Energy Attributes Dataset is built on data from the UCLA California Center for Sustainable Communities' (CCSC's) *Energy Atlas.* The Energy Atlas links utility account and billing data to building attributes across California, including in Los Angeles. This database provides an invaluable source of consumption history for electricity and natural gas. It can be coupled with *ResStock* to better understand what consumption patterns might look like for electrified buildings and transportation across Los Angeles.

While ResStock provides the load shapes and predicted changes in these shapes for electricity and natural gas throughout the year, it does not specify further than building type. Thus, it does not capture the geography or program elements of each segment's consumption. Taking recent historical consumption as a baseline, the Energy Atlas enables users to understand the potential energy burden impacts of various decarbonization measures under future electricity pricing scenarios in *different parts of the city.* Differentiating historical consumption (as well as other characteristics) geographically is important from an equity perspective because it captures neighborhood-level distinctions not represented in *ResStock*. These include average building or unit size, vintage, and quality, all which impact and will be generally represented in consumption patterns from the Energy Atlas.

When combined with data on income, current EV adoption levels, and annual miles driven, the Energy Atlas data provides a snapshot of our "equity starting point" for residential energy consumption across Los Angeles.

For the LA RESET Tool specifically, the Energy Atlas provides the median annual electricity and natural gas consumption by segment. Although building type by the five ResStock building designations is not a formal part of the Energy Atlas, residential buildings across the city were assigned to one of these five building types based on a crosswalk between LA County property designations and the building types.[15] Program enrollment is provided by the utilities, and therefore was already embedded into Energy Atlas data.

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[15] See Supporting Files, "lac_parcel_usetype_attributions_crosswalk.csv" file for specific assignments.

Although the median annual electricity and natural gas consumption values have been provided in a simplified format (one median value for electricity and one median value for gas for each segment), a large amount of processing was required to get them there. An overview of this process is outlined in the following subsection.

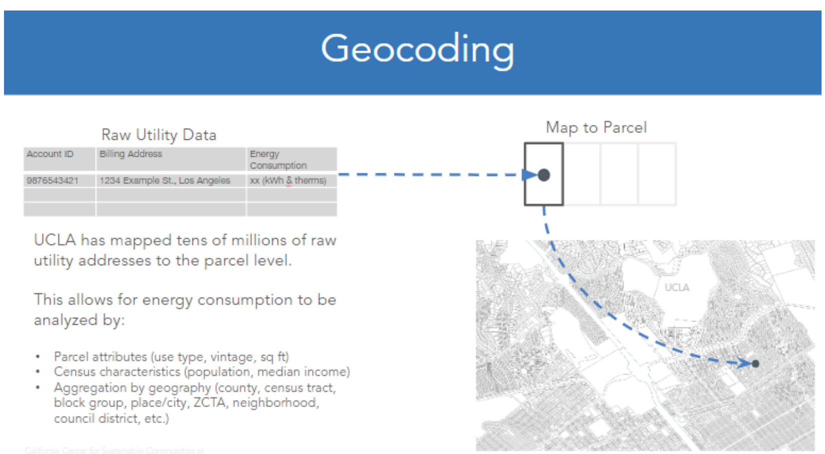
2.2.2.1.1. Energy Atlas: Bill Processing and Geocoding

UCLA’s CCSC receives historical natural gas billing data from SoCalGas and historical electricity data from LADWP. This billing data represents all customers across the utilities’ territories.

These bills are translated into annual medians through a multi-stage process. Energy consumption billing data is organized around billing dates that are specific to individual customers. Some accounts have mid-month billing cycles, while others may have billing dates that span multiple months (or even multiple years) for a single charge. In those cases, the UCLA team must calendarize consumption, which assigns consumption to specific months. The Atlas utilizes an in-database calculation routine that implements utility bill monthly calendarization. Consumption for year and month is inferred from the raw bills by splitting on monthly boundaries and re-aggregating by the relevant ID in the utility data. The resulting "calendarized" data is then used for subsequent analysis and the calculation of yearly totals.

These bills are also assigned to geolocations so they can be aggregated into the geographies of interest in the tool (Census Tract, ZCTA, and Council District). The key to the Energy Atlas is the backend relational database and the ability to maintain spatial relationships among all datasets. The confidential backend utilizes an open-source PostgreSQL database system with Post-GIS extension to manage these spatial relationships. Utility addresses are geocoded and spatially joined to associated parcel datasets, census data, and any other municipal or administrative boundaries. See Figure 5 for a visualization of this process.

Figure 5. Overview of Geocoding for Energy Atlas Data.



Geocoding the account addresses is fundamental to linking account locations with other reference geographies such as cities, census blocks, and parcels. Geocoding is an iterative process, and the success (match) rate varies based on the geocoding method, completeness of parcel reference data by county, completeness of utility account addresses, and level of accuracy.

Not all meters are or should be associated with specific parcels. For example, telecommunications infrastructure dispersed throughout a neighborhood may be physically located on a parcel, but the energy use should not be attributed to that parcel's energy consumption; doing so might distort the energy use intensity statistics.[16]

Customer addresses have many internal inconsistencies in formatting and are organized differently from entity to entity. CCSC researchers process the addresses through SQL/regular expression batch "cleaning" in order to make them usable for the locators and geocoding tools. This process converts heterogeneous addresses strings into a standardized record format suitable for geocoding, as well as loading into the database.

Due to this necessary processing, updating the Energy Attributes Dataset would require additional collaboration between LADWP and UCLA.

2.2.2.2. American Community Survey (ACS) Data: Median Renter Income and Median Owner Income

The tool uses American Community Survey (ACS) data for its Census Tract- and ZCTA-level income information. The ACS, a survey put out by the U.S. Census Bureau to collect social and economic characteristics of the population, publishes data on median household income by housing tenure, including median income of owner-occupied and renter-occupied households. These data are reported in table B25119: Tenure by Household Income in the Past 12 Months (in Inflation-Adjusted Dollars),[17] and have been incorporated into CCSC's Energy Atlas. Specifically, the Atlas contains (and the tool uses) median income data from the 2022 ACS 5-year estimates.

Because the ACS does not collect or report income by building type or program enrollment, the renter-occupied and owner-occupied median household incomes are combined with EZ-Save and Lifeline eligibility caps to approximate these segment-level differences. All segments in the Energy Attributes Dataset that represent multi-family households (Multi-Family 2-4 Units and Multi-Family 5+ Units) as well as Mobile Homes are assigned the lesser of the median renter-occupied income for their geography or to the program income cap for a household of 3.[18][19] Segments representing single-family households (Single Family Attached and Single Family Detached) are assigned the median owner-occupied income for their geography or to the program income cap for a household of 2. See Table 2 for specific assignment details.

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[16] For this reason, meters belonging to streetlights, traffic lights, and non-building-based accounts are intentionally removed from parcels and aggregated separately.

[17] https://data.census.gov/table/ACSDT5Y2022.B25119?q=TENURE%20BY%20income%20in%20los%20angeles%20city

[18] Based on the average household size in Los Angeles of 2.7 members: https://www.census.gov/quickfacts/fact/table/losangelescitycalifornia/HSD310222

[19] Lifeline cap is $55,450 regardless of household size, https://finance.lacity.gov/tax-education/tax-exemptions/lifeline-utility-users-tax-exemption-seniors-and-individuals. The EZ-Save cap for a household of 3 s $51,640 https://www.ladwp.com/residential-services/assistance-programs/ez-save-program.

Table 2. Median household income assignments by building type and program enrollment

Building Type	Program Enrollment	Median Income Used
Single Family Attached	Non-Assistance	Median Owner Income
Single Family Attached	Lifeline	Lesser of Median Owner Income or $55,450
Single Family Attached	EZ-Save (or Lifeline & EZ-Save)	Lesser of Median Owner Income or $51,640
Single Family Detached	Non-Assistance	Median Owner Income
Single Family Detached	Lifeline	Lesser of Median Owner Income or $55,450
Single Family Detached	EZ-Save (or Lifeline & EZ-Save)	Lesser of Median Owner Income or $51,640
Mult-Family 2-4 Units	Non-Assistance	Median Renter Income
Multi-Family 2-4 Units	Lifeline	Lesser of Median Renter Income or $55,450
Multi-Family 2-4 Units	EZ-Save (or Lifeline & EZ-Save)	Lesser of Median Renter Income or $51,640
Multi-Family 5+ Units	Non-Assistance	Median Renter Income
Multi-Family 5+ Units	Lifeline	Lesser of Median Renter Income or $55,450
Multi-Family 5+ Units	EZ-Save (or Lifeline & EZ-Save)	Lesser of Median Renter Income or $51,640
Mobile Home	Non-Assistance	Median Renter Income
Mobile Home	Lifeline	Lesser of Median Renter Income or $55,450
Mobile Home	EZ-Save (or Lifeline & EZ-Save)	Lesser of Median Renter Income or $40,880

These income assignments are a major assumption in the tool. We recognize that many single-family units, for example, are renter-occupied. And there are certainly owner-occupied apartments. However, we believe that the difference in income level between these two groups, especially within-geography, generally translates to the difference in income level between Angelenos who can afford single family homes and those who live in apartments. At the city level, there is a large difference between these median incomes: owner-occupied households in Los Angeles have a median annual income of $122,071, whereas renter-occupied households in Los Angeles have a median annual income of $57,996. Further, many customers enrolled in EZ-Save or Lifeline will have incomes below the eligibility cap, or have larger households with incomes above the cap for three-person households. That being said, we made these assumptions so that we could estimate energy burden with the tools at our disposal.

2.2.2.3. CalMatters Data: EV Adoption % by ZIP Code

To represent the current differences in EV adoption across the city, we utilize a public CalMatters dataset on EV demographics in California.[20] This dataset includes EV adoption % in 2021 by ZIP Code (or ZCTA), which is matched directly for ZCTA segments in the Energy Attributes Dataset. For Census Tract segments, EV adoption % is assigned based on the ZCTA that the Census Tract falls into. Council District and DAC/Non-DAC segments are assigned weighted averages of % EV adoption from the ZCTAs within their boundaries (using number of premises for weighting).

EV adoption percentages beyond the baseline year (which is based on the CalMatters 2021 values) are assumed to increase 3.5% per year – the average of the projected growth rates for 200-mile and 300-mile range EVs, from the Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) 2023, Reference Case.[21] This estimate is stored in the solar and vehicle assumptions file "pv_ev_specs.csv". For more information on vehicle assumptions, see section 2.2.7 *Vehicle Logic and Assumptions.*

2.2.2.4. Bureau of Transportation Statistics: Annual Weekday Vehicle Miles Traveled by Census Tract

To calculate spending on gasoline or electricity for personal vehicle use, it is necessary to incorporate estimates of vehicle miles traveled (VMT) in different areas across the city. To do this, we utilize a Bureau of Transportation Statistics public dataset – the Local Area Transportation Characteristics for Households (LATCH).[22] LATCH reports household weekday VMT by census tract for 2017. We multiply these values by 250 (the number of weekdays in 2017) to represent annual VMT. This is likely an undercount of annual VMT, because weekends are excluded, but it was chosen due to a lack of data on weekend travel. It is assumed that most residents drive significantly fewer miles on the weekends.

Another major assumption in the tool is that VMT stays consistent over the next 20 years. Thus, these values are not adjusted as the tool's main yearly loop advances.[23]

2.2.2.5. Preparing the Energy Attributes Dataset for Use in the Tool

There are four segment types within the Energy Attributes Dataset: Census Tracts, ZCTAs, Council Districts, and DACs/Non-DACs. Each was separately constructed and eventually combined into a large dataset for ease of use in the tool. This construction included many steps

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[20] Data was collected, combined, and cleaned by CalMatters. Data can be found here: https://github.com/CalMatters/ev-zipcode-demographics-data.

[21] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=48-AEO2023&region=1-0&cases=ref2023&start=2021&end=2050&f=A&linechart=ref2023-d020623a.4-48-AEO2023.1-0~ref2023-d020623a.10-48-AEO2023.1-0~ref2023-d020623a.11-48-AEO2023.1-0~ref2023-d020623a.12-48-AEO20

[22] https://www.bts.gov/latch/latch-data

[23] Future versions of the tool with a greater focus on vehicle energy consumption could certainly integrate projections of how VMT will change in the future. For example, the SCAG's regional travel demand model includes projections of VMT in 2045: https://gisucla.maps.arcgis.com/home/item.html?id=89e205a8bf6d471184bddf90d2763174#overview. However, their estimates are not represented by census tract or ZCTA, so they were not used for this project.

of matching and data aggregation. It was completed in both Excel and Python using simple statistical tools, VLOOKUPs/joins, and some spatial overlaying with the GeoPandas package.

The **Census Tract** segments were the most straightforward to construct, as the majority of attributes were available at the tract level, and therefore could be matched directly. The process started with selecting the Energy Atlas outputs for LADWP electricity consumption by segment (tract, building type, and program enrollment). The output included annual consumption for the years 2016-2021, but only 2021 values were used.[24] The specific variables that were used in the dataset included the tract geoid, the building type, the status of EZ-Save, Lifeline, and NEM enrollment (3 separate columns), median annual kWh consumption, and number of premises in the segment (which is used to calculate weighted averages).

For segments where the kWh consumption was masked due to too few premises, per the 100 residential customer minimum rule,[25] the masked value (represented as -99999999) was replaced with the city-wide median for that segment type.[26] In the CSV, the “simulated_elec,” column was added to denote whether the kWh value was masked and replaced with the city-wide median (see Figure 9 for an example of masked segments before medians were imposed). Segments that do not exist (e.g., Mobile Homes in Bel Air) also do not exist in the dataset. In some cases, this causes holes in the output maps.

Figure 9. Example of raw data from Energy Atlas, including masked values (-9999999). These values were replaced with city-wide medians during the cleaning process. All other (non-masked) values were not edited.

	A	B	C	D	E	F	G	H	I	J	K
1	la_council_district_num	year	recs_building_type_premise	has_ez_save	has_lifeline	has_nem	kwh_monthly_total	premise_kwh_monthly_avg	premise_kwh_monthly_median	premise_tally	parcel_tally
2	2	2019	Mobile Home	f	f	f	-999999999	-999999999	-999999999	5	4
3	6	2018	Mobile Home	f	t	f	-999999999	-999999999	-999999999	22	4
4	6	2021	Mobile Home	f	f	t	-999999999	-999999999	-999999999	1	1
5	1	2017	Multi-Family 2-	f	f	t	-999999999	-999999999	-999999999	7	7
6	1	2017	Multi-Family 2-	t	f	t	-999999999	-999999999	-999999999	2	2
7	1	2017	Multi-Family 2-	t	t	f	-999999999	-999999999	-999999999	31	30

These values were then combined with the Energy Atlas SoCalGas median consumption values by segment (tract, building type, and program enrollment). These outputs also included 2016-2021 values; again, only 2021 values were used. As for electricity consumption, for segments where the natural gas consumption was masked due to too few premises, the masked value (represented as -99999999) was replaced with the city-wide median for that segment type. In the CSV, a column, “simulated_ng,” was added to denote whether the natural gas value was masked and replaced with the city-wide median.

Because LADWP’s and SoCalGas’s billing information is stored in separate places within the Energy Atlas, it was not technically possible to produce exact pairs of natural gas and electricity consumption by segment. More specifically, because program enrollment was endogenous to

[24] This year was chosen because it was the most recent available.

[25] https://energyatlas.ucla.edu/p/f6dcd166-e0d9-4112-ba81-ed80ccbea7d0

[26] The city-wide medians were also provided by CCSC for this purpose.

each utility (unlike building type and geoid, which were measured in both datasets), we assumed a relationship between LADWP program enrollment and SoCalGas program enrollment. The only SoCalGas program considered here was CARE – the low-income assistance program for investor-owned utilities in California – so it was assumed that all segments representing either EZ-Save or Lifeline program enrollment would also represent CARE enrollment. That assumption was used to "match" segment portions and create comprehensive LADWP-SoCalGas segments.[27]

Once the LADWP and SoCalGas data were combined for the segments – including the geography, geoid, building type, program enrollments, premise tally, and "simulated" columns – other attributes were matched to the dataset. Census tracts were designated as DAC or Non-DAC based on SB 535 designations.[28] They were then assigned a ZIP Code based on a Housing and Urban Development (HUD) ZIP Code-Census Tract crosswalk file.[29] This ZIP Code was used to assign an LADWP Electric Zone.[30] as well as EV adoption percentage taken from the CalMatters EV Demographics dataset.[31] Annual miles, from the LATCH dataset,[32] were reported, and therefore assigned, by Census Tract. Finally, each segment was matched to its Census Tract's median household income for renters and median household income for owners. For more information on how the tool eventually assigns income for each segment's energy burden calculation, see Table 2.

Though more complicated, constructing the remaining segment types (ZCTA, Council District, and DAC vs. Non-DAC) followed a similar process. Thus, rather than repeat the explanation of that process, the following paragraphs focus on the steps unique to their respective processes. To begin constructing the **ZCTA** segments, median values for electricity and natural gas consumption were shared by the Energy Atlas. These values were limited to just those from 2021, and any masked values were replaced with city-wide medians. The "simulated" columns were filled in accordingly, and LADWP and SoCalGas segment portions were matched to create comprehensive segments. Segments were assigned a ZIP Code matching their ZCTA geoid, which was used to assign an LADWP Electric Zone and EV adoption percentage. Using the Census Tract-ZCTA crosswalk, annual miles for each ZCTA were calculated as the weighted average of the miles from the Census Tracts within that ZCTA, with weighting done by number of premises in each census tract. The DAC column was assigned placeholder 2 (as ZCTA's are neither DAC nor Non-DACs).

The **Council District** segments were more challenging, as much of the data was not available for these (irregular!) shapes. Thus, spatial overlays and weighted averages were utilized to achieve the best estimates. Luckily, Council District electricity and natural gas consumption values were shared directly from the Energy Atlas thanks to its internal aggregation process.

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[27] Premise tallies were taken from the LADWP portion of the segment.

[28] https://oehha.ca.gov/calenviroscreen/sb535

[29] https://www.huduser.gov/apps/public/uspscrosswalk/home. See supporting files, "ZIP_TRACT_062024."

[30] https://www.ladwp.com/sites/default/files/documents/Residential_Electric_Zones_Table.pdf. See Supporting Files, "zip_zone" for a spreadsheet version of the pdf.

[31] https://github.com/CalMatters/ev-zipcode-demographics-data. See supporting files, "ev-zipcode-demograhpics.csv."

[32] https://www.bts.gov/latch/latch-data

Thus, the energy portion of the segments were prepared the same way as for the Census Tracts and ZCTAs. However, all other values (Census Tract or ZCTA/ZIP based) required external aggregation. Using a Python GeoPandas-based script and the GIS geometries of the Council Districts and ZCTAs,[33] each ZCTA was first assigned to a Council District based on majority spatial overlap. Then, each Council District's zone, EV adoption percentage, annual miles driven, and median household income for renters and owners were all calculated as weighted averages of the ZCTAs it contained. Averages were weighted by the number of premises in each ZCTA. The DAC column was given a placeholder 2, and the ZIP column was given a placeholder 99999.

The **DAC vs. Non-DAC** segments are also comprised of aggregated values. In this case, no exact values were available for these regions (including median electricity and natural gas consumption), so all values were generated from weighted averages of the DAC vs. Non-DAC Census Tract segments. Weighted averages were calculated by number of premises per segment for the median kWh consumed, median therms consumed, zone, EV adoption percentage, annual miles driven, and median household income for renters and owners. No values were simulated (so those columns were all zeros), the DAC column was given the placeholder 2 value, and the ZIP column was given the placeholder 99999. Building type and the four program enrollment columns were specified by segment.

The Energy Attributes Dataset is saved as one large spreadsheet ("energy_attributes.csv") including the segments for all four types of geographies.

Table 3. Energy Attributes Table CSV Structure

CSV Col	A	B	C	D	E	F	G
Category	**geography**	**geoid**	**building_type**	**has_ez_save**	**has_lifeline**	**has_nem**	**has_care**
Example	Census Tract	6037101110	Multi-Family 2-4 Units	f	f	f	f
What is this?	Geography type – enables user to select either "Census Tract," "ZCTA," "Council	Label for the segment's geography, will be formatted according to the Geography Type	Building type for the segment – enables the user to select either "Mobile Home," "Multi-Family 2-4 Units,"	Is this an EZ-Save segment? (f =	Is this a Lifeline segment? (f = No, t = Yes)	Is this a Net Energy Metered segment?	Is this a CARE segment? (f = No, t = Yes). CARE segments will always also have either EZ-

[33] The ZCTA/council district overlay is visualized here: https://www.arcgis.com/apps/mapviewer/index.html?webmap=bf3336b5bdad49b7ac679ef3a6671015

	District," or "DAC/Non-DAC"	(i.e., Census Tract label, ZCTA label, Council District number, or DAC/Non-DAC)	"Multi-Family 5+ Units," "Single Family Attached," or "Single Family Detached"	No, t = Yes)		(f = No, t = Yes)	Save, Lifeline, or both

CSV Col	H	I	J	K	L	M
Category	**premise_kwh_median**	**premise_tally**	**premise_therms_median**	**simulated_ng**	**simulated_elec**	**dac**
Example	3422	109	264	1	0	1
What is this?	The median annual electricity consumed by households in this segment (in kWh). Assumed to be the "baseline" ResStock scenario	The number of premises (LADWP customer households) included in this segment from the Energy Atlas. Used for some weighted averages	The median annual natural gas consumed by households in this segment (in therms). Assumed to be the "baseline" ResStock scenario.	Was the natural gas value (Col J) originally masked and replaced with the city-wide median for that building type-program enrollment combo? (1 = yes, 0 = no).	Was the electricity value (Col H) originally masked and replaced with the city-wide median for that building type-program enrollment combo? (1 = yes, 0 = no).	Is this segment a DAC? (1 = yes, 0 = no, 2 = not a Census Tract). Only Census Tracts have DAC/Non-DAC status.

CSV Col	N	O	P	Q	R	S
Category	**zip**	**zone**	**ev_perc**	**annual_miles**	**mhi_owner**	**mhi_renter**
Example	91042	2	0.0279	8910	92083	55521
What is this?	Assigned Zip Code. ZCTAs and Census Tracts have Zip Codes assigned, Council Districts and DACs/Non-DACs have a placeholder "99999".	LADWP Climate Zone (1 or 2). Assigned by Zip Code for ZCTA and Census Tracts, and weighted average for Council District and DAC/Non-DAC.	Percentage of EV adoption in that geoid, in decimal form (0.0279 = 2.79%). Not differentiated by building type or program enrollment (the same across all segments within one geoid).	Average annual miles driven per household in that geiod. Not differentiated by building type or program enrollment (the same across all segments within one geoid).	Median household income for owner-occupied units in that geoid (in $/year). Not differentiated by building type or program enrollment (the same across all segments within one geoid).*	Median household income for renter-occupied units in that geoid (in $/year). Not differentiated by building type or program enrollment (the same across all segments within one geoid).*

*Internal logic of the tool assigns income to the segment depending on building type and program enrollment status (see Table 2. Median household income assignments by building type and program enrollment).

2.2.3. LADWP Residential Electricity Rates

Electricity bills are calculated in the tool using LADWP's R-1A Standard Residential Service Rates.[34] Electricity consumption based on the calculations in the LA RESET Tool's building and vehicle modules are aggregated to the monthly level, and then each month is assigned to a tier, including corresponding Power Access Charge and Energy Charge per kWh.[35] Tiers are

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[34] https://www.ladwp.com/account/customer-service/electric-rates/residential-rates

[35] Although DWP bills are technically delivered bimonthly, the tool calculates consumption and bill cost per month. This is for the sake of simplicity and consistency with SoCalGas bills, which are delivered monthly.

assigned based on the total monthly kWh consumption and a segment's Climate Zone-based tier limits (**Figure 6** and **Table 4**).

Figure 6. LADWP territory Climate Zone Designations[36]

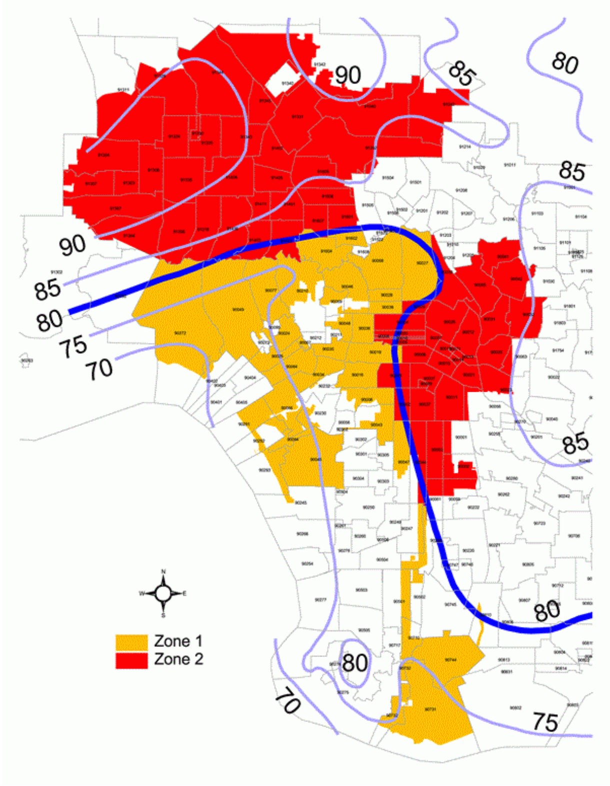

Table 4. Electricity Bill Tier Allocations by LADWP Climate Zone

	Zone 1		Zone 2	
	Monthly	**Bi-Monthly**	**Monthly**	**Bi-Monthly**
Tier 1	First 350 kWh	First 700 kWh	First 500 kWh	First 1,000 kWh
Tier 2	Next 700 kWh	Next 1,400 kWh	Next 1,000 kWh	Next 2,000 kWh
Tier 3	Above 1,050 kWh	Above 2,100 kWh	Above 1,500 kWh	Above 3,000 kWh

The 2024 rates are taken directly from LADWP's residential rates webpage,[37] and each month is assigned Tier 1-3 Consumption Charges ($/kWh) based on the rates for 2024, as well as the

[36] For a list of ZIP Code designations used by the tool, see Supporting Files "zip_zone.csv" or go to https://www.ladwp.com/sites/default/files/documents/Residential_Electric_Zones_Table.pdf

[37] https://www.ladwp.com/account/customer-service/electric-rates/residential-rates

three tiers of Power Access Charges ($/month) (see Table 5). These can easily be updated to reflect updated “baseline year” rates. For more information on the structure of the CSV that holds these rates, see *Technical Overview, Supporting CSV* files.

Table 5. LADWP residential Power Access Charge (top) and Total Consumption Charge (bottom) by tier for 2024, as used in the tool.

Power Access Charge per Month		
Tier 1	Tier 2	Tier 3
2.30	7.90	22.70

R-1A	Total Consumption Charge (includes Adjustment Factors)		
	Tier 1	Tier 2	Tier 3
Period Applicable	2024		
January - March	0.20042	0.25901	0.25901
April - May	0.19645	0.25504	0.25504
June	0.19645	0.25504	0.34205
July - September	0.21169	0.27028	0.35729
October - December	0.21408	0.27267	0.27267

Segments representing net energy metering (NEM) customers are also included in the tool. The bills (and bill credit, if solar production exceeds consumption in any given month) for these segments are also calculated using R-1 rates and the NEM rider.[38] These bills are calculated based on the NEM Guidelines, including that credits from the value of excess solar generation can be used to offset future bills, but not the minimum $10 charge or the Utility Users Tax (UUT).[39]

The R-1 rates are adjusted for each year into the future based on projected rate increases from the 2022 SLTRP, which are applied to the Energy Charge ($/kwh) exclusively. Rate projections are explained in a later section, *LADWP 2022 Case-by-Case Rate Projections.*

2.2.3.1. Preparing the LADWP Rates for Use in the Tool

The file containing baseline electricity rates for 2024 (“electric_pricing.csv”) includes one set of values (one row) for each month of the year. The values in each row are: the month (column A), days in the month (column B), and the customer charges in $/month for tiers 1-3 (columns C-E). These customer charges are the same for each month of the year and will not change unless

[38] Although NEM customers are eligible to opt for time-of-use rates as well, we assume that all customers in the tool are on tiered (R-1) rates.

[39] https://www.ladwp.com/sites/default/files/2023-09/NEM%20Guidelines%20%28with%20April%202021%20technical%20modification%29%20%281%29.pdf

there is a structural rate action. They are taken from LADWP's Residential Rates page, for the R1-A rate.[40]

The energy charges in $/kWh for tiers 1-3 for each month are also listed in the CSV (columns F-H). Unlike the customer charges, these are updated every 2-3 months. The values listed in the CSV have been taken from the same Residential Rates page (see **Table 5**). As new rates come out – for example, for January-March 2025 – these $/kWh rates can be used to replace the 2024 rates.

2.2.4. Southern California Gas Natural Gas Rates

The tool uses a recent set of residential natural gas rates (GR) from SoCalGas (July 2023-June 2024) as the baseline-year rates for natural gas consumption.

There are several components to natural gas rates. The rates that most significantly impact bills are the core procurement charges, which are set by the utility and updated monthly. Core procurement charges include the following:

- **Customer charge:** A flat rate, daily charge per meter, which is 16.438¢ and has not changed since 2003 or earlier.
- **Procurement charge:** Also called the "commodity rate," this is the cost of gas purchased by SoCalGas. Customers pay this rate per therm of gas used. The procurement charge is the same for baseline and non-baseline gas usage.
- **Transmission charge:** Also called the "transportation rate," this is the cost of transporting the gas to customers' homes. There are two transmission rates: the baseline rate, and a higher non-baseline rate for gas usage beyond the baseline energy usage for each customer's climate zone.

In addition to the core procurement charges, there are a few other rates that contribute to natural gas bills:

- **Public Purpose Program (PPP) surcharge,** updated annually in January. This per-therm fee funds programs like CARE and is set by SoCalGas each year. CARE customers pay a substantially lower PPP rate.
- **State Regulatory Fee (SRF),** updated periodically (no clear pattern). This per-therm fee funds the California Public Utilities Commission and is set by the state.

Historical natural gas rate data were collected from approved Advice Letters published on the SoCalGas website,[41] as well as the "Natural Gas Prices Explained" SoCalGas webpage.[42] The core procurement charges are listed on the "Schedule No. GR" page of each monthly "Core Procurement Charge Update" advice letter. The PPP rates can be found in the advice letters titled "Update of Public Purpose Program Surcharge Rates." When the SRF is altered, it can be found in the advice letters titled "Update of CPUC Reimbursement Account User Fees." Recent rates can also be found in the "Residential Rates (xlsx)" file linked near the bottom of the "Natural Gas Prices Explained" page. This resource often has rate updates more quickly than Advice Letters are posted.

[40] https://www.ladwp.com/account/customer-service/electric-rates/residential-rates

[41] https://tariffsprd.socalgas.com/scg/filings/content/?utilId=SCG&bookId=GAS&flngStatusCd=Approved

[42] https://www.socalgas.com/billing-payment/understanding-my-bill/natural-gas-prices-explained

2.2.4.1. Preparing the SoCalGas Rates for Use in the Tool

The SoCalGas natural gas rates are less straightforward than the LADWP residential electricity rates and required analysis of SoCalGas Advice Letters to identify the relevant charges.

All natural gas rate data were collected from approved Advice Letters published on the SoCalGas website.[43] The core procurement charges are listed on the "Schedule No. GR" page of each monthly "Core Procurement Charge Update" advice letter. These core charges include GR Baseline Procurement and Transmission, GR Non-Baseline Procurement and Transmission, and a Baseline Allowance that depends on the user's climate zone. The PPP rates can be found in the advice letters titled "Update of Public Purpose Program Surcharge Rates." The PPP surcharge updates every January. When the State Regulatory Fee is altered, it can be found in the advice letters titled "Update of CPUC Reimbursement Account User Fees." These updates do not happen as consistently as the PPP updates, but we recommend checking the advice letters periodically for changes. The values gleaned from this Advice Letter were consolidated to create a spreadsheet with a similar structure to that of the electricity rates spreadsheet. Each month is represented as a row, with column values for number of days and each of the various customer charge values listed in the Advice Letters.

2.2.5. LADWP 2022 Case-by-Case Rate Projections

A key component of the LA RESET Tool is the set of future rate projections under different SLTRP cases or scenarios. The tool has been structured to utilize the most up-to-date SLTRP rate projections, which, as of writing, are the 2022 SLTRP Case 1, 2, 3 and SB100 projections. These projections can be replaced by the 2024 LA100 Plan projections when those are ready.

Because rate projections are delivered as a single average per kWh Energy Charge per year (e.g., $0.25/kWh) – and don't include every component of residential rates – each set of projections is translated into percentage increases over 2024 rates. As the tool calculates electricity bills for each successive year, these rate projection percentage increases are applied to the original LADWP electricity rates to represent what rates will look like in that year. The percentage increases from the selected case or scenario are applied to the energy charges ($/kWh), but not to the customer access charge ($/month) or utility user tax. Additionally, these percentage increases are represented in real 2022 $, which is important for the sake of consistency with income data, which are also represented in real 2022 $.

[43] https://tariffsprd.socalgas.com/scg/filings/content/?utilId=SCG&bookId=GAS&flngStatusCd=Approved

Figure 7. Sample Calculation: How Rate Projections are Applied in the Tool

Example: Bill for 200 kWh in January - 2024 vs. 2027 (Case 1)

Baseline Rates (from "electric_pricing.csv")

Month	Days	Cust Charge T1	Cust Charge T2	Cust Charge T3	En Charge T1	En Charge T2	En Charge T3
January	30	2.3	7.9	22.7	0.20042	0.25901	0.25901

Percentage Increases (from "ladwp_elec_rates_increases.csv")

Year	SB100	Case 1	Case 2	Case 3
2024	0	0	0	0
2025	0.109	0.06	0.06	0.103
2026	0.125	0.2	0.241	0.283
2027	0.224	0.252	0.252	0.292

$$Bill = Customer\ Charge\ T1 + En\ Charge\ T1 * (1 + Perc\ Increase\ ) * kWh$$

$$2024\ Bill = 2.30 + 0.20042 * (1 + 0) * 200 = 2.30 + \ 0.20042 * 200 = \$42.384$$

$$2027\ Bill = 2.30 + 0.20042 * (1 + 0.252\ ) * 200 = 2.30 + 0.25092 * 200 = \$52.485$$

2.2.5.1. Preparing the LADWP Rate Projections for Use in the Tool

The LADWP rate projections by SLTRP Case were originally shared in the form of a simple spreadsheet with four rows for the four cases: SB100, Case 1, Case 2, and Case 3. Each case included average customer rates ($/kWh) provided by LADWP's Financial Services Organization for the years 2022 through 2045, presented in nominal 2022 dollars. For use in the tool, the structure of this spreadsheet was modified in two major ways: 1) nominal 2022 dollars were translated to real 2022 dollars, with an assumption of 2.5% inflation, and 2) prices were translated from $/kWh to % increase in $/kWh from $/kWh in 2024.

The first step was undertaken using the following equations:

$$Inflation\ Factor = (1 + Inflation\ Rate)^{(current\ year - base\ year)}$$

$$Real\ 2022\ \$\ Price = \frac{Nominal\ Price}{Inflation\ Factor}$$

Thus, each cell containing a nominal price was replaced with a real 2022 dollars price.

For an updated set of rate projections, this same process can be undertaken either using the Python script or in Excel.

Once real 2022 dollars prices were outputted, the second step was to translate these prices into percentage increases over 2024 dollars for the "ladwp_elec_rate_increases.csv" file. This was done for each of the four cases using the following equation:

$$Percentage\ Increase\ for\ year\ x = \frac{Price\ in\ year\ x - Price\ in\ 2024}{Price\ in\ 2024}$$

This file, “ladwp_elec_rate_increases.csv,” includes the FSO rate projections by SLTRP Case translated into percentage rate increases over the baseline year values (the baseline year values are the values in the “elec_pricing.csv” file).

As long as this structure is maintained (Case or Scenario column names, Year row names, and % increase over 2024 rates), the data can be replaced with values representing updated projections and the tool will still function.

Table 6. LADWP Residential Rate Projections (in Percentage Increase over 2024 Rates) by SLTRP Case, CSV Format

CSV Col	A	B	C	D	E
Category	**Year**	**SB100**	**Case 1**	**Case 2**	**Case 3**
Example	2024	0	0	0	0
Example	2025	0.109	0.06	0.06	0.103
What is this?	Year for the percentage increase	Projected percentage increase in average electricity rates for that year, over rates in 2024, for SB100. Presented in **real 2022 $*** (in decimal form: 0.109 = 10.9%)	Projected percentage increase in average electricity rates for that year, over rates in 2024, for Case 1. Presented in **real 2022 $*** (in decimal form: 0.06 = 6%)	Projected percentage increase in average electricity rates for that year, over rates in 2024, for Case 2. Presented in **real 2022 $*** (in decimal form: 0.06 = 6%)	Projected percentage increase in average electricity rates for that year, over rates in 2024, for Case 3. Presented in **real 2022 $*** (in decimal form: 0.103 = 10.3%)

*Assuming 2.5% inflation

2.2.6. California Energy Commission Rate Projections

To incorporate future natural gas prices into its calculations of energy burden, the LA RESET Tool uses a 2023-2045 forecast from the California Energy Commission (CEC) that measures residential natural gas prices for SoCalGas customers in 2023 $ per MMBtu. The CEC models natural gas prices every two years as part of a statutorily mandated process called the Integrated Energy Policy Report (IEPR).[44]

Completed in 2023, the most recent IEPR includes forecasts for both 1) natural gas’s commodity prices and 2) its end-use prices (e.g. residential and commercial). It makes projections under three scenarios: Base Supply (of natural gas), High Supply, and Low Supply (in the tool these are referenced as “Moderate Price,” “Low Price,” and “High Price”).

[44] https://www.energy.ca.gov/data-reports/reports/integrated-energy-policy-report

The end-use prices include a 2023-2045 forecast of residential natural gas prices for SoCalGas customers. The tool incorporates this forecast under the three aforementioned scenarios (Base, High, and Low).

The CEC's commodity prices forecast come from the 2023 North American Market Gas-trade (NAMGas) model, while the end-use price forecast comes from a model that builds upon NAMGas by accounting for the transportation costs to deliver natural gas to its customers (or "end uses").

The "delivered rates" generated by the latter model are summarized by the following equation:

$$Delivered\ Cost\ by\ End\ Use = Commodity\ Cost + Transportation\ Rate$$

2.2.6.1. NAMGas model

The NAMGas model simulates supply, transmission, and demand in the North American natural gas market to identify moments of economic equilibrium across the market's various nodes.

NAMGas generates annual commodity prices, supply volumes, and demand volumes. The model is North America-wide, including Canada and northern Mexico. That is, its price projections account for nodes across the natural gas system to simulate the reality that gas prices in California (and elsewhere) are influenced by events in other regions.

NAMGas has outputs for three scenarios: Base Supply, High Supply, and Low Supply.

The **Base Case (Moderate Price)** represents business as usual, a world with similar policies, economics, and technological capacity to the status quo.

- In the Base Case, prices at the SoCal Citygate fall about 23% in 2023, another 3% in 2024, then plateau around $5.30/MMBtu through 2050 (in 2022 dollars).

The **High Case (Low Price)** assumes a high availability of natural gas, low production costs, and a high level of technological advancement, which makes supply cheaper and more abundant.

- SoCal Citygate prices follow a similar pattern in the High Case – a drop followed by a plateau – but at about 50 cents lower per MMBtu than the Base Case.

The **Low Case (High Price)** is the opposite of the High Case: it assumes low availability of natural gas, high production costs, and sluggish technological growth.

- The Low Case sees SoCal Citygate prices start around 50 cents higher than the Base Case and rise roughly 1% per year, hitting 2050 at about $6.36/MMBtu.

More detailed assumptions for each scenario can be found on the CEC website, where they are available for download (see slides 6 and 7 of the Natural Gas Preliminary Price Projections presentation).[45]

2.2.6.2. Delivered-Rates Model

The CEC's End-Use-Delivered-Rates forecast builds on NAMGas by accounting for transportation costs between the citygate and end users. The modeling incorporates 15

[45] https://www.energy.ca.gov/event/webinar/2023-04/staff-webinar-preliminary-gas-price-projections

commodity price points from NAMGas, 31 price points from within the WECC region, 15 interstate pipeline company tariff rates, and modeled transportation rates for PG&E, SoCalGas, and San Diego Gas & Electric.

To calculate transportation costs (and SoCalGas rates), the model assumes that each utility's revenue requirement will grow 4% every year until 2050.

Residential demand for natural gas was projected using SoCalGas's 2023 demand as a base and applying the CEC's modeled annual demand change out to 2035. From 2035 to 2050, demand is held constant.

2.2.6.3. Preparing the CEC Rate Projections for Use in the Tool

The tools projections of natural gas prices in the future ("cec_ng_rate_increases.csv") are taken from the CEC's IEPR forecast for SoCalGas residential natural gas rates. It includes projections under three scenarios: Base Supply (of natural gas), High Supply, and Low Supply (in the tool these are referenced as "Moderate Price," "Low Price," and "High Price").

Unlike the SLTRP, these projections were shared in real $, and thus did not have to be adjusted for inflation to be used in the tool. However, they were translated into percentage increases so that they could be easily used to transform the procurement and transmission portions of the natural gas rates for future years. The equation used to translate specific prices into percentage increases is:

$$Percentage\ Increase\ for\ year\ x = \frac{Price\ in\ year\ x - Price\ in\ 2024}{Price\ in\ 2024}$$

2.2.7. Vehicle Logic and Assumptions

To represent the energy burden impacts of internal combustion engine (ICE) vehicles and EVs, the tool includes some major estimates and assumptions about efficiency for both types of vehicles. These estimates were gathered from a variety of sources for the City of Los Angeles, LA County, California, and the entire US.[46]

The assumed average miles per gallon (MPG) for gas-powered vehicles is 26.94, which is the estimated real-world MPG of non-diesel, non-alternative fuel vehicles for 2023.[47] The assumed average miles per gallon equivalent (MPGE) for EVs is 97, which is the approximate average of light duty EVs for 2023,[48] where 1 gallon of gasoline is equivalent to approximately 33.7 kWh (based on equivalent BTUs [115,000], as per EPA definition).

The LA RESET Tool allows users to select one of three EV charging options: residential charging, Level 2 public/workplace charging, and DCFC public/workplace charging. The tool assumes that residential charging uses a Level 2 charger and delivers an average current of 7.2 kW; that Level 2 public/workplace charging averages 7 kW at a cost of $8.15 for four hours of continuous charging (28 kWh), averaging out to a total cost of $0.29/kWh; and that DCFC

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[46] Most of these assumptions can be edited in the "pv_vehicle_assumptions.csv" file if users would like to replace them with different or more up-to-date values.

[47] https://www.epa.gov/automotive-trends/explore-automotive-trends-data#SummaryData

[48] https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10191S7.pdf

public/workplace charging averages 110 kW power at a cost of $23.26 for 30 minutes of continuous charging (55 kWh), averaging out to a total cost of $0.42/kWh. In years beyond 2024, these prices are adjusted at the same rate of increase (based on selected SLTRP Case) as the residential electricity rates.

The Level 2 public/workplace assumptions are based on sampling of publicly available data for 78 low-power stations in the City of Los Angeles from PlugShare.[49] The DCFC assumptions are based on sampling of publicly available data for 8 high-power stations in the City of Los Angeles, excluding no-charge stations; this data also comes from PlugShare.

The tool also assumes that charging proceeds uninterrupted from the time the user starts charging to the time the EV is fully charged. The tool does not account for factors influencing charging time on the margin, such as differences in charging rates based on battery charge level.

2.2.8. Solar Output Curve

The tool uses a solar production curve from PVWatts for the ZIP Code 90068,[50] using the default options provided for 1kW of residential rooftop solar (**Table 7**).

Table 7. PVWatts System Info for Solar Production Estimate

DC System Size (kW):	1	System Losses (%):	14.08
Module Type:	Standard	Tilt (deg):	20
Array Type:	Fixed (open rack)	Azimuth (deg):	180

The hourly production curve for this 1kW system is stored as the "pv_1kw_90068.csv" file for use by the tool, and its total output (1695 kWh) is stored in the "pv_vehicle_specs.csv." An estimate for the size of the average rooftop solar array, which is used to scale up the 1kW array output, is also stored in the "pv_vehicle_specs.csv" file.

The output curve is utilized to estimate NEM segment building consumption *without* the production from solar.[51] Estimated production from solar is added onto the consumption total from the Energy Atlas for building energy calculations, and then subtracted back out for billing calculations. The elements of this process are demonstrated in Figure 8. In the figure, which represents one day of the 365 days that the tool models,[52] the PVWatts solar production curve is depicted in orange, the estimated building consumption curve is depicted in blue, and the net consumption/production curve is depicted in green.

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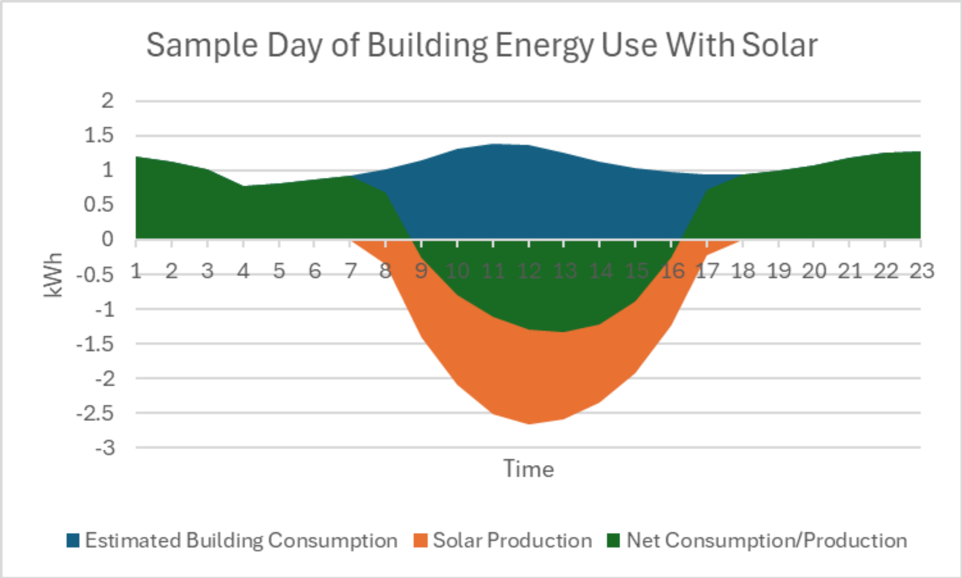
[49] https://www.plugshare.com/

[50] https://pvwatts.nrel.gov/pvwatts.php. The ZIP Code 90068 was chosen because its output was about the median of the kWh outputs from various ZIP Codes across LA, which only varied by about 4% annually overall. Future iterations of the tool could include more detailed solar outputs, such as those matching the specific ZIP Codes of the segments.

[51] Because we only receive the *net* consumption for NEM households from the Energy Atlas, this is necessary to accurately estimate consumption patterns before and after building upgrades.

[52] This curve depicts consumption/production for a NEM segment in a scenario without home EV charging.

Figure 8. Depiction of Estimated Building Consumption and Solar Production for NEM Segment



For NEM customers, the tool constructs the blue curve first based on the load shape of the chosen ResStock upgrade scenario and the quantity of estimated building kWh:

$$Estimated\ Building\ kWh = Solar\ PV\ Production + (NEM\ kWh\ median\ * upgrade\ scenario\ multiplier)$$

The solar production curve is added later, and then the green net consumption/production curve is calculated for use in the billing module.

An important note for solar PV considerations in the tool is that we assume that **rooftop solar adoption stays constant in future years**. The reason for this assumption is that, in lieu of better information on how net energy metering affects LADWP's revenue requirements – and the cross subsidization from non-solar adopters to solar adopters – we could not accurately predict how increasing solar adoption would impacts rates, and by extension, energy burden. At the current level of adoption, however, we assume that the impact of NEM cross-subsidization on rates is negligible.[53] Future iterations of the tool with a greater focus on DERs could certainly provide more flexibility.

2.2.8.1. Preparing the Solar Output for Use in the Tool

The solar production comes from the output of NREL's PVWatts Calculator for a 1kW rooftop solar array in ZIP Code 90068. It was constructed from a subset of the downloaded results (Hourly). That subset covers cells L32:L8792 in the output spreadsheet, which include the AC System Output (W).

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[53] See NREL's LA100 Equity Strategies Chapter 5, Affordability, for more discussion and analysis on NEM cross-subsidization: https://www.nrel.gov/docs/fy21osti/79444-ES.pdf.

2.2.9. Solar and Vehicle Assumptions

In addition to the sample year of hourly output produced by PVWatts, the tool also relies on a set of assumptions about PV system size and EV efficiency and charging.

These are stored in the PV and EV assumptions file (“pv_vehicle_assumptions.csv”), which provides a convenient place to see and update assumptions for the vehicle and solar PV calculations in the tool. Its starting “Value(s)” have been estimated from a variety of sources.

2.2.9.1. Preparing the Solar and Vehicle Assumptions for Use in the Tool

The structure of the “pv_vehicle_assumptions.csv” file is among the simplest in the tool, as it is formatted to function as a dictionary in Python that can be edited by users without changing the script. As long as the “Variable” column (A) is unchanged, numbers in the “Values” column (B) can be replaced with updated or different values.

Table 8. Solar and Electric Vehicle Assumptions Referenced by the Tool, CSV Format

CSV Col	A	B
What is this?	**Variable**	**Value**
Annual estimated kWh generated by 1kW of rooftop solar in LA zip code 90068.[54] Used as a proxy for net-metered customers' solar production (when multiplied by rooftop solar size, below).	solar_output_1kw	1694.762
Estimated rooftop solar size (in kW) used by the tool.	rooftop_solar_kw	4
Average estimated vehicle mpg used by the tool[55]	gas_vehicle_avg_mpg	26.94
Estimated average efficiency for EVs in miles per gallon equivalent (mpge)*	ev_avg_mpge	97
Estimated charging rate for at-home level 2 charging, in kWh	lvl2_charger_rate	7.2
Starting time for the at-home EV charging, in military time (18 = 6pm)	at_home_start_time	18
Estimated price (in $/kWh) for charging an EV at a level 2 public charger (in 2024)	lvl2_public_starting_price	0.29
Estimated price (in $/kWh) for charging an EV at a public DC fast charger (in 2024)	dcfc_public_starting_price	0.42
Estimated starting average price of gasoline in $	gasoline_starting	4.5
Estimated annual growth rate of EV ownership (in decimal form, 0.035 = 3.5%)	ev_adoption_rate	0.035

* Translated into kWh in the tool assuming 33.7 kWh = 1 gallon of gasoline[56]

2.2.10. Gasoline Price Projections

The LA RESET Tool's gasoline projections derive from two data sources: the EIA's 2023 Annual Energy Outlook (AEO),[57] and estimates surrounding California's Low Carbon Fuel Standard (LCFS) program.[58]

The 2023 AEO provides baseline estimates for future gasoline prices, while the LCFS estimates extra costs associated with California's regulation of gasoline and other carbon-intensive transportation fuels. The tool combines these two sources to create a single projection of gasoline prices.

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[54] See section 2.2.8 Solar Output for more information on how solar production is integrated into the tool.

[55] See 2.2.9 Vehicle Logic and Assumptions for more information on EV assumptions and sources.

[56] https://www.epa.gov/fueleconomy/text-version-electric-vehicle-label#5.

[57] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=70-AEO2023&region=1-9&cases=ref2023&start=2021&end=2050&f=A&linechart=~~~~~~ref2023-d020623a.15-70-AEO2023.1-9&map=ref2023-d020623a.3-70-AEO2023.1-9&ctype=linechart&sourcekey=0

[58] https://ww2.arb.ca.gov/sites/default/files/2023-09/lcfs_sria_2023_0.pdf#page=64

2.2.10.1. Source 1: EIA 2023 Annual Energy Outlook

The EIA Annual Energy Outlook (AEO) is a series of projections produced using the EIA's National Energy Modeling System (NEMS). The latest available version is 2023.

The projections we use for the LA RESET Tool cover 2022-2050. They are available in both real/inflation-adjusted (2022) and nominal dollars, but the tool uses the real values. They cover the Pacific census region, which includes CA, WA, and OR.

The NEMS consists of several modules (e.g. the Natural Gas Market Module, the Coal Market Module, and the Renewables Module) that forecast supply, demand, and prices based on factors like legislation and historical trends. These models come together in the Integrating Module.[59]

AEO 2023's scenarios are referred to as "cases." The baseline or "reference" case assumes 1) that "no radical changes in residential-sector technology or consumer behavior will occur through 2050" and 2) that we will see "no new regulations of efficiency beyond current law and no new government programs fostering efficiency improvements."[60]

Other cases include High Economic Growth, Low Economic Growth, High Zero-Carbon Technology Cost, Low Zero-Carbon Technology Cost, and more (including combinations thereof).[61]

2.2.10.1.1. 2023 AEO: Gasoline-Specific Assumptions

AEO 2023's gasoline projections[62] come from the Liquid Fuels Market Module,[63] which models production and distribution of conventional and reformulated gasoline.[64] The Pacific census region is assumed to consume 26% conventional and 74% reformulated gasoline. This is based on 2015 market shares.[65]

To make the gasoline price projections California-specific, the tool combines the AEO projections with estimated price increases resulting from the California Air Resources Board's LCFS program.

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59 https://www.eia.gov/outlooks/aeo/assumptions/

60 See here for further reference case assumptions: https://www.eia.gov/outlooks/aeo/assumptions/pdf/RDM_Assumptions.pdf#page=7

61 A description of each case is available here: https://www.eia.gov/outlooks/aeo/assumptions/pdf/case_descriptions.pdf

62 https://www.eia.gov/outlooks/aeo/data/browser/#/?id=70-AEO2023&region=1-9&cases=ref2023&start=2021&end=2050&f=A&linechart=~~~~~~ref2023-d020623a.15-70-AEO2023.1-9&map=ref2023-d020623a.3-70-AEO2023.1-9&ctype=linechart&sourcekey=0

63 https://www.eia.gov/outlooks/aeo/assumptions/pdf/LFMM_Assumptions.pdf

64 https://www.eia.gov/outlooks/aeo/assumptions/pdf/LFMM_Assumptions.pdf#page=9

65 Other assumptions for the Liquid Fuels Market Module are available here: https://www.eia.gov/outlooks/aeo/assumptions/pdf/LFMM_Assumptions.pdf#page=9; detailed methodology is available here: https://www.eia.gov/outlooks/aeo/nems/documentation/lfmm/pdf/LFMM_AEO2022_Documentation.pdf; and legislation that's been incorporated into the module is summarized here: https://www.eia.gov/outlooks/aeo/assumptions/pdf/LFMM_Assumptions.pdf#page=26

The LCFS program creates a market-based system of credits and deficits in which regulated parties (producers and importers of specified transportation fuels) can either generate credits or deficits depending on whether their investments help reduce or increase GHGs beyond an established baseline.[66]

In 2023, CARB staff proposed amendments to the program that they estimated would lead to increases in gasoline prices for retail consumers.[67] To calculate those increases, they made two key assumptions:

1. Any cost increases faced by producers and importers as a result of the amendments would be passed on entirely to customers.
2. Revenues generated through the amended LCFS program would be passed on to consumers only in certain cases.

Based on these assumptions, CARB staff estimate that the average price of gasoline will rise $1.15 per gallon from 2031 through 2046.[68] To account for that increase, the tool combines it with the 2023 AEO forecast.

As of Nov. 5, 2024, CARB was still in the process of approving these amendments.[69]

2.2.10.2. Preparing the Gasoline Price Projections for Use in the Tool

The tool's "gasoline_increases.csv" file utilizes two data sources to adjust gasoline prices for future years: the EIA's 2023 AEO,[70] and estimates surrounding California's LCFS program.[71]

The 2023 AEO provides baseline estimates for future gasoline prices, while the LCFS estimates extra costs associated with California's regulation of gasoline and other carbon-intensive transportation fuels. Each of these sources is included as a column in the gasoline price adjustment file: the EIA projection used as a multiplier for the baseline gasoline $/gallon and the LCFS estimate used as an adder

The EIA projection was translated from the annually projected "Motor Gasoline: End User Price[s]" to a percentage increase over the 2024 values, in the same process as with the electricity and natural gas rates. These prices were already presented in 2022 $/gallon, so there was no need to translate from nominal to real prices. The equation that was used to calculate percentage increase is:

$$Percentage\ Increase\ for\ year\ x = \frac{Price\ in\ year\ x - Price\ in\ 2024}{Price\ in\ 2024}$$

[66] https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/about#:~:text=The%20LCFS%20is%20designed%20to%20encourage%20the%20use%20of%20cleaner,dependence%20in%20the%20transportation%20sector.

[67] https://ww2.arb.ca.gov/sites/default/files/2023-09/lcfs_sria_2023_0.pdf

[68] https://ww2.arb.ca.gov/sites/default/files/2023-09/lcfs_sria_2023_0.pdf#page=64

[69] https://ww2.arb.ca.gov/rulemaking/2024/lcfs2024

[70] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=70-AEO2023&region=1-9&cases=ref2023&start=2021&end=2050&f=A&linechart=~~~~~~ref2023-d020623a.15-70-AEO2023.1-9&map=ref2023-d020623a.3-70-AEO2023.1-9&ctype=linechart&sourcekey=0

[71] https://ww2.arb.ca.gov/sites/default/files/2023-09/lcfs_sria_2023_0.pdf#page=64

The LCFS adder column was taken from Table 22 of the 2023 Standardized Regulatory Impact Assessment (SRIA) document. Each year beyond 2024 (in which we assume the adder has already been internalized in the starting price of gasoline) includes the projected LCFS pass-through.

3. How to Use the Tool

3.1. Accessing the Tool

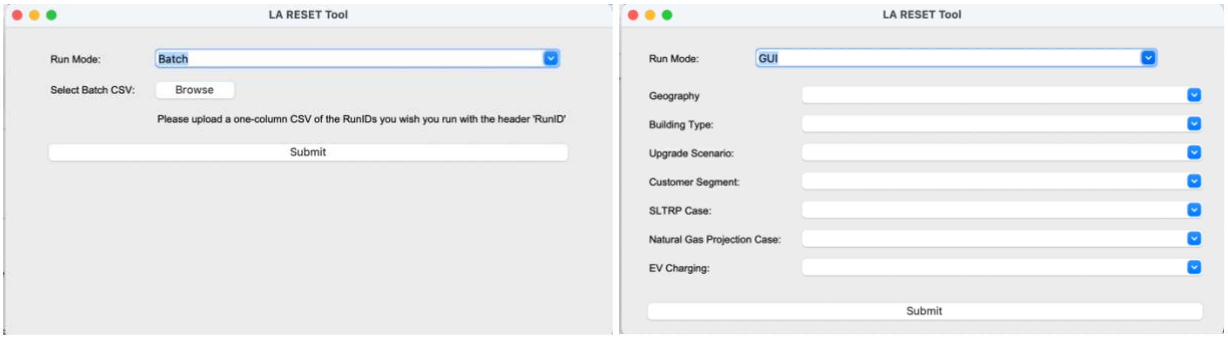
The tool is structured as a Python script saved as a .py file (“batch_EBT_2025.py”). It can be accessed through the user’s Python command terminal, in a prepackaged .exe file, or as a notebook in a Python environment like Jupyter Notebook or JupyterLab. For the tool to run in the terminal or a Python environment, the “data” folder, which contains the supporting CSV and GPKG files, must be located in the same directory as the Python script.

The tool also requires that the following Python packages are installed: pandas, numpy, datetime, math, matplotlib.pyplot, geopandas, os, and tkinter.

3.1.1. Selecting Scenarios to Run

When the user runs the tool, a GUI will pop up to solicit inputs. These can either be provided in a “batch” of RunIDs (see 4.3.1 for more information) or with the “GUI” that enables the user to select from dropdowns for the seven variables (**Figure 11**). Altogether, there are 11,880 possible combinations for tool runs, and the batch process can run any number of combinations at a time.

Figure 11. LA RESET Tool GUI, “batch” upload option (left) or manual selection (GUI) option (right)



Once selections are made and user presses submit, the GUI will close, and the terminal will print the RunID (or unique ID for the chosen combination of inputs) and each of the selections. If that combination has been run before and the output folder still exists, the terminal will print that the RunID has already been executed, and the tool run will be cancelled. If using the batch option, the tool will run sequentially through each RunID in the provided list.

A tool run will take between a few seconds and over an hour, depending on the number of segments for the chosen combination of inputs (e.g., there are many more census tract segments than council district segments, so a census tract run will be much slower). For all geography types other than DAC-Non-DAC (which is usually only a few seconds), a progress bar will pop up to give some indication of how long a run will be.

Once the run(s) are complete, the progress bar will close. Some warnings about data deprecation and the tick marks on the maps will pop up, but these can be ignored.

3.2. Updating Underlying Data and Script

The tool is designed modularly, so that most data updates can be made without having to touch the python script. Any data that is stored in a csv can be updated, as long as the format is maintained, without affecting the tool's operation.

Updates can also be made to the Python script, and to the structure of the supporting CSVs. However, doing so may compromise the integrity of the tool.

3.3. Interpreting Tool Outputs

At the end of a run, the tool automatically produces a folder of outputs representing projections based on the user inputs. Each run's folder and output are named to reflect the combination of selected user inputs, or the "RunID." For batch runs, each inputted RunID will have its own folder.

3.3.1. RunID

Assigning each combination of selected user inputs a "RunID" enables outputs to be more easily referenced and compared, and also enables the tool to check whether a combination has already been run. The RunID is created by assigning a number to each user input, creating a string of those numbers. For the upgrade scenarios, of which there are 11, we use the hexadecimal "A" for the 11th option. The assigned values are listed in **Table 9**.

Table 9. RunID Assigned Values by Input and Option

Input	Option	Run ID Value
Geography	Census Tract	0
	ZCTA	1
	Council District	2
	DAC_Non-DAC	3
Building Type	Mobile Home	0
	Multi-Family 2-4 Units	1
	Multi-Family 5+ Units	2
	Single Family Attached	3
	Single Family Detached	4
Upgrade Scenario	Baseline	0
	Basic Enclosure	1
	Enhanced Enclosure	2
	Heat Pump Water Heaters	3
	Heat Pumps High Efficiency Electric Backup	4
	Heat Pumps Min Efficiency Electric Backup	5
	Heat Pumps Min Efficiency Existing Heating as Backup	6
	Whole Home Electrification High Efficiency	7
	Whole Home Electrification High Efficiency Plus Basic Enclosure Package	8

	Whole Home Electrification High Efficiency Plus Enhanced Enclosure Package	9
	Whole Home Electrification Min Efficiency	A
Customer Segment	All Customers	0
	Non-Discount Only	1
	EZ-Save Only	2
	Lifeline Only	3
	EZ-Save and Lifeline	4
	NEM Only	5
SLTRP Case	SB100	0
	Case 1	1
	Case 2	2
	Case 3	3
Natural Gas Projections	Moderate Price	0
	High Price	1
	Low Price	2
EV Charging	At-Home	0
	Public Level 2	1
	Public DCFC	2

Thus, an example of a RunID for a run with the following inputs: ZCTAs, Mobile Homes, Baseline, Lifeline Only, Case 1, Moderate Price, and At-Home charging would be “1003100”.

The tool outputs folder for this run would be labeled “1003100,” and the files would be labeled “1003100_segment_table.csv,” “1003100_geoid_table.csv,” “1003100_energy_burden_table.csv” and “1003100_map_2024.jpg,” “1003100_map_2030.jpg,” etc.

3.3.2. Segments Table

The most extensive and unedited form of the tool’s output for a single run is the segments table, which includes estimated energy burden and associated characteristics and calculated spending for each segment. These values are reported for each year between 2024 and 2045. The segments table will be named “RunID_segment_table.csv”.

A description of each of the columns in the output table is provided in the tables below:

Table 10. Segments Output Table CSV format

CSV Col	A	B	C	D	E	F	G	H
Output Label	**Geography**	**geiod**	**Building Type**	**Upgrade Scenario**	**Year**	**EZ-Save**	**Lifeline**	**NEM**
Example	Council District	8	Multi-Family 2-4 Units	Baseline	2024	f	f	t
What is it?	Either "Census Tract," "ZCTA," "Council District," or "DAC/Non-DAC"	Label for the census tract, ZCTA, council district, or DAC/Non-DAC	One of the five building types, as selected by the user	One of eleven upgrade scenarios, as selected by the user	Year	Is this an EZ-Save segment? (f = No, t = Yes)	Is this a Lifeline segment? (f = No, t = Yes)	Is this a Net Energy Metered segment? (f = No, t = Yes)

CSV Col	I	J	K	L	M	N	O
Output Label	**CARE**	**Segment Premises**	**Zip**	**Zone**	**Average Household Miles**	**Percent EV Adoption**	**Median Household Income**
Example	f	146	99999	2	7548.908	0.009912	68177.13
What is it?	Is this a CARE segment? (f = No, t = Yes)	Number of premises represented in that segment	Zip Code Associated with that segment/GeoID – Council Districts and DACs/Non-DACs have 99999 as a placeholder	LADWP Climate Zone	Average vehicle miles travelled by household in 2017 for that geoid	Percent EV Adoption in that GeoID in 2021, in decimal form (.05 = 5%)	Median household income in that GeoID (see Table 2 for assignment logic), in $

CSV Col	P	Q	R	S	T	U	V
Output Label	**Electricity Usage**	**Electricity Usage w EV**	**Natural Gas Usage**	**Gasoline Usage**	**Electricity Spending**	**Electricity Spending w EV**	**Natural Gas Spending**
Example	2006.785	4678.52	264.2121	245.037	2275.128	3051.83	506.5961
What is it?	Median annual electricity usage for customers in that segment without an EV, in kWh	Median annual electricity usage for customers in that segment with an EV, in kWh	Median annual natural gas usage for that segment in therms	Median annual gasoline usage for that GeoID in gallons	Median annual spending on electricity for the building in that segment in $	Median annual spending on electricity for EV owners (building + EV) in that segment in $	Median annual spending on natural gas in that segment in $

CSV Col	W	X	Y	Z	AA	AB	AC
Output Label	**Gasoline Spending**	**Public Charging Spending**	**EV Spending on Transport Fuel**	**Total Spending w EV**	**Total Spending w ICE**	**Energy Burden EV Customer**	**Energy Burden ICE Customer**
Example	1102.666	0	776.702	3051.83	3377.795	0.044763	0.049544
What is it?	Median annual spending on gasoline for ICE vehicle owners in that GeoID	Median annual spending on public charging for EV owners in that GeoID (if public charging was not chosen by the user, this will be zero) in $	Median total spending on electricity, natural gas, and public charging for EV owners in that segment in $	Median total spending on electricity, natural gas, and public charging for EV owners in that segment in $	Median total spending on electricity, natural gas, and gasoline for ICE owners in that segment in $	Median annual energy burden for customers with EVs in that segment in decimal format	Median annual energy burden for customers with ICE vehicles in that segment in decimal format

CSV Col	AD	AE	AF
Output Label	**Average Total Spending w Vehicle**	**Building Only Energy Burden**	**Average Energy Burden w Vehicle**
Example	3214.7975	0.025523	0.049497
What is it?	Average of the median total spending on electricity, natural gas, and vehicle fuel for both EV and ICE users (based on # of EV vs. ICE vehicles) in $	Median annual energy burden considering natural gas and electricity bills (not vehicle spending) in that segment in decimal format	Median annual energy burden for customers in the segment (based on breakdown of EV vs. ICE vehicles) in decimal format

3.3.3. GeoIDs Table

The next form of output from the tool is a geoid output table. It presents the same information as the segment table, but aggregated by weighted average to produce one set of values per geoid. These values are eventually used for mapping purposes. The file name for the table is "RunID_geoid_table.csv."

Table 11. GeoIDs Output Table CSV format

CSV Col	A	B	C	D	E	F	G	H

Output Label	geoid	Year	Building Type	Upgrade Scenario	Total Premises	Average Household Miles	Percent EV Adoption	Median Household Income
Example	1	2024	Multi-Family 2-4 Units	Baseline	13914	7229.434	0.0268	43581.20
What is it?	Label for the census tract, ZCTA, council district, or DAC/Non-DAC	Year	One of the five building types, as selected by the user	One of eleven upgrade scenarios, as selected by the user	Number of premises represented in that segment	Average vehicle miles travelled by household in 2017 for that geoid	Percent EV Adoption in that GeoID in 2021, in decimal form (.0268 = 2.68%	Estimated median household income in that GeoID (see Table 2 for assignment logic), in $

CSV Col	I	J	K	L	M	N	O	P
Output Label	Electricity Usage	Natural Gas Usage	Gasoline Usage	Electricity Spending	Electricity Spending w EV	Natural Gas Spending	Gasoline Spending	Public Charging Spending
Example	2879.185	233.74796	234.68099	653.42468	653.4246868	424.3387718	1056.064496	713.5449701
What it mans	Estimated median annual electricity usage for that segment in kWh	Estimated median annual natural gas usage for that segment in therms	Estimated median annual gasoline usage for that GeoID in gallons	Estimated median annual spending on electricity for the building in that segment in $	Estimated median annual spending on electricity for EV owners (building + EV) in that segment in $	Estimated median annual spending on natural gas in that segment in $	Estimated median annual spending on gasoline for ICE vehicle owners in that GeoID	Estimated median annual spending on public charging for EV owners in that GeoID (if public charging was not chosen by the user, this will be zero) in $

CSV Col	Q	R	S	T	U	V	W	X
Output Label	EV Spending on Transport Fuel	Total Spending w EV	Total Spending w ICE	Average Total Spending w Vehicle	Energy Burden EV Customer	Energy Burden ICE Customer	Building Only Energy Burden	Average Energy Burden w Vehicle
Example	776.702	1366.969657	1709.489	3214.7975	0.031368	0.039232	0.025523	0.039021
What is it?	Estimated median total spending on electricity, natural gas, and public charging for EV owners in that segment in $	Estimated median total spending on electricity, natural gas, and public charging for EV owners in that segment in $	Estimated median total spending on electricity, natural gas, and gasoline for ICE owners in that segment in $	Average of the median total spending on electricity, natural gas, and vehicle fuel for both EV and ICE users (based on estimated EV and ICE vehicle adoption) in $	Estimated median annual energy burden for customers with EVs in that segment in decimal format	Estimated median annual energy burden for customers with ICE vehicles in that segment in decimal format	Estimated median annual energy burden considering natural gas and electricity bills (not vehicle spending) in that segment in decimal format	Estimated median annual energy burden for customers in the geoid (based on estimated EV and ICE vehicle adoption) in decimal format

3.3.4. Energy Burden Table

The Energy Burden Table just presents the overall energy burden (Column U from the GeoID table) for each geoid for each year from 2024-2045. The file name for the table is "RunID_energy_burden_table.csv."

Table 12. Energy Burden Output Table CSV format

CSV Col	A	B	C	D	E		W
Category	geoid	2024	2025	2026	2027		2045
Example	90004	0.040099	0.042513	0.042723	0.043795	…	0.047352
What is it?	Geoid label	Overall energy burden for customers in that geoid, including vehicle, based on selected customer segments, in 2024. In decimal form (0.04009 = 4.01%)	Overall energy burden for customers in that geoid, including vehicle based on selected customer segments, in 2025. In decimal form (0.04251 = 4.25%)	Overall energy burden for customers in that geoid, including vehicle based on selected customer segments, in 2026. In decimal form (0.04272 = 4.27%)	Overall energy burden for customers in that geoid, including vehicle based on selected customer segments, in 2027. In decimal form (0.04380 = 4.38%)		Overall energy burden for customers in that geoid, including vehicle, based on selected customer segments, in 2045. In decimal form (0.04735 = 4.74%)

3.3.5. Maps

The tool is currently structured to create five .jpg maps based on the Energy Burden Table values from five key years: 2024, 2030, 2035, 2040, and 2045. These maps represent the projected overall energy burden for each geoid for the selected year. Only geoids with segments that exist (based on the user specifications) are mapped, although the general outline of Los Angeles[72] is included for reference. Some user specifications, such as those with Mobile Homes or Single Family Attached residents, will lead to sparse maps because there are a limited number of these types of units across Los Angeles.[73] See Figure 12 for an example.

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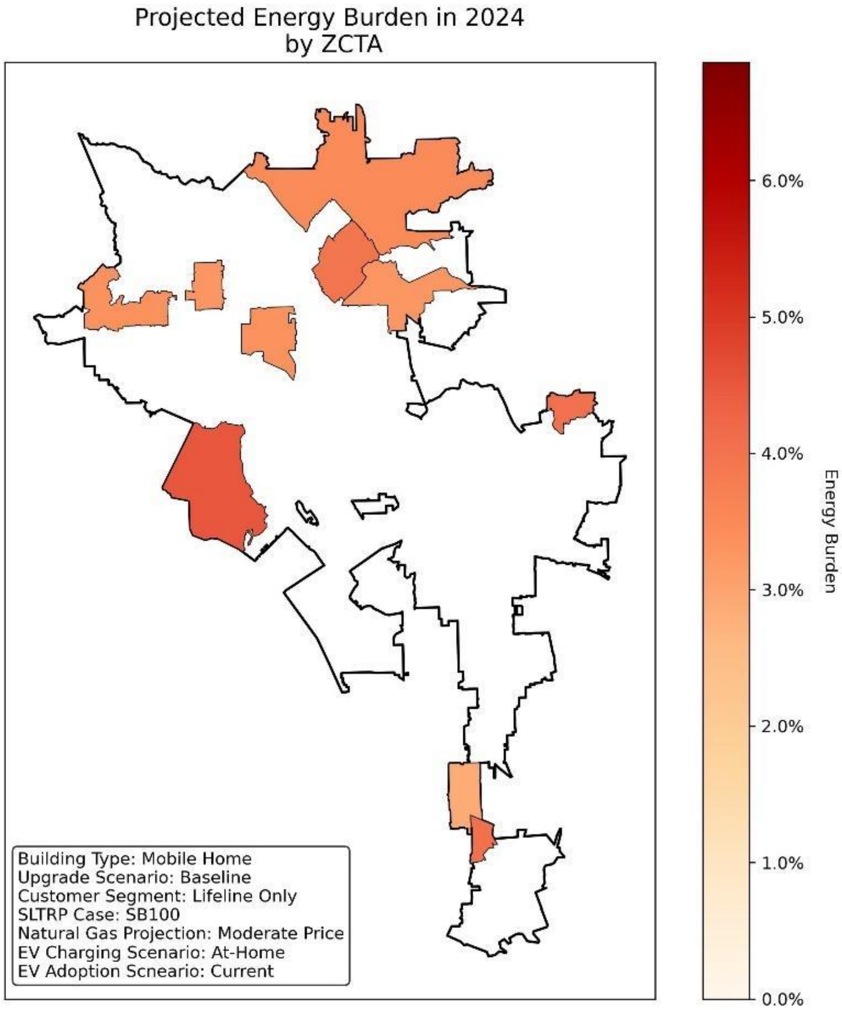
[72] Outline is a reflection of the outline of all segments that overlap with LA – so the ZCTA map, for example, is slightly larger because ZCTA borders do not match up with the LA city boundary.

[73] For more information on how the segments and their data were constructed, see *Conceptual Overview, Primary Datasets, Energy Attributes Dataset.*

Figure 12. Example of Sparsely Populated Map: ZCTAs with Mobile Homes on Lifeline Rate



The maps include a color bar legend for the energy burden of each geoid. The color bar range will be consistent across all five maps produced by a single run, enabling comparison of how energy burden changes over time. However, due to the inability to predict all of the possible ranges of energy burden percentage, each run will have its own range represented on the color bar (calculated by the tool based on the maximum energy burden on that run). That means that it will be important for viewers to look at the values on the color bar in order to compare energy burden maps from different tool runs. For example, **Figure 13** includes a comparison between maps from different tool runs. The first tool run only had a range of just over 5% energy burden, whereas the second tool run had a range that extended above 8% energy burden.

Figure 13. Examples from two different tool runs: (top) DAC_Non-DAC, Single Family Detached and (bottom) Council District, Multi-Family 5+ Units