Clean Energy Planning with SLOPE

The State and Local Planning for Energy Platform

EECBG Webinar

October 2023

Megan Day, Senior Energy Planner, National Renewable Energy Laboratory (NREL)

NREL Transforming ENERGY

SCEP STATE & COMMUNITY ENERGY PROGRAMS

Supporting Data-Driven Decisions to Achieve Community Energy Goals

SLOPE
State and Local Planning for Energy
U.S. DEPARTMENT OF ENERGY

SLOPE is a free and easy-to-access online platform that helps energy planners at state and local levels make data-driven decisions to achieve their communities' energy goals.

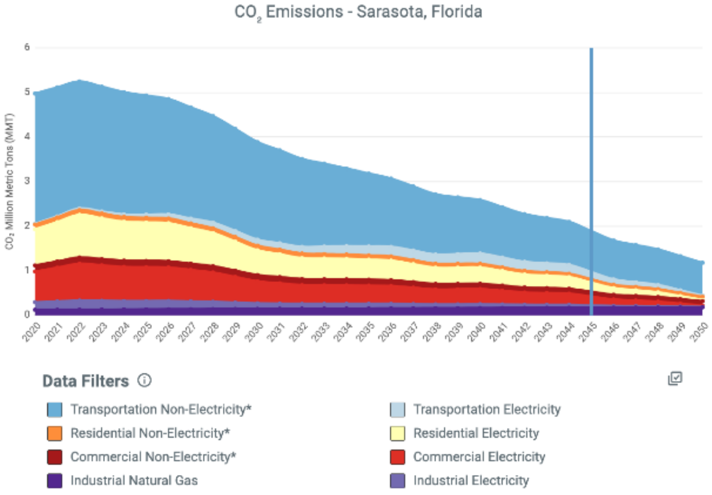
- **Scenario Planner:** Explore the impacts of different energy transition scenarios on the energy consumption, carbon dioxide (CO_2) emissions, and system costs at county, state, and national scales.
- **Data Viewer:** Dive into city, county, and state data on renewable energy, energy efficiency, and sustainable transportation potential and projections as well as jobs and equity data.

SLOPE is an Office of State and Community Energy Programs (SCEP)-led, cross-U.S. Department of Energy collaboration.

slope@nrel.gov

maps.nrel.gov/slope

Scenario 2: 95% Grid Decarbonization by 2050 & Widespread Electrification



Scenario Planner: Sarasota County, Florida CO_2 Emissions under Widespread Electrification and Grid Decarbonization Scenario

BIOENERGY TECHNOLOGIES OFFICE (BETO)	STRATEGIC ANALYSIS (SA)	BUILDING TECHNOLOGIES OFFICE (BTO)	GEOTHERMAL TECHNOLOGIES OFFICE (GTO)	SOLAR ENERGY TECHNOLOGIES OFFICE (SETO)	VEHICLE TECHNOLOGIES OFFICE (VTO)	WATER POWER TECHNOLOGIES OFFICE (WPTO)	WIND ENERGY TECHNOLOGIES OFFICE (WETO)

Google: NREL SLOPE

Or

https://maps.nrel.gov/slope

SLOPE

Scenario Planner

SLOPE Scenario Planner

To deliver county-level scenario results, the SLOPE team integrated results from five of NREL's flagship models, along with scenarios from two of NREL's innovative energy sector analyses:

Regional Energy Deployment System (ReEDS)

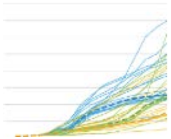
Distributed Generation Market Demand (dGen™)

ResStock™

ComStock™

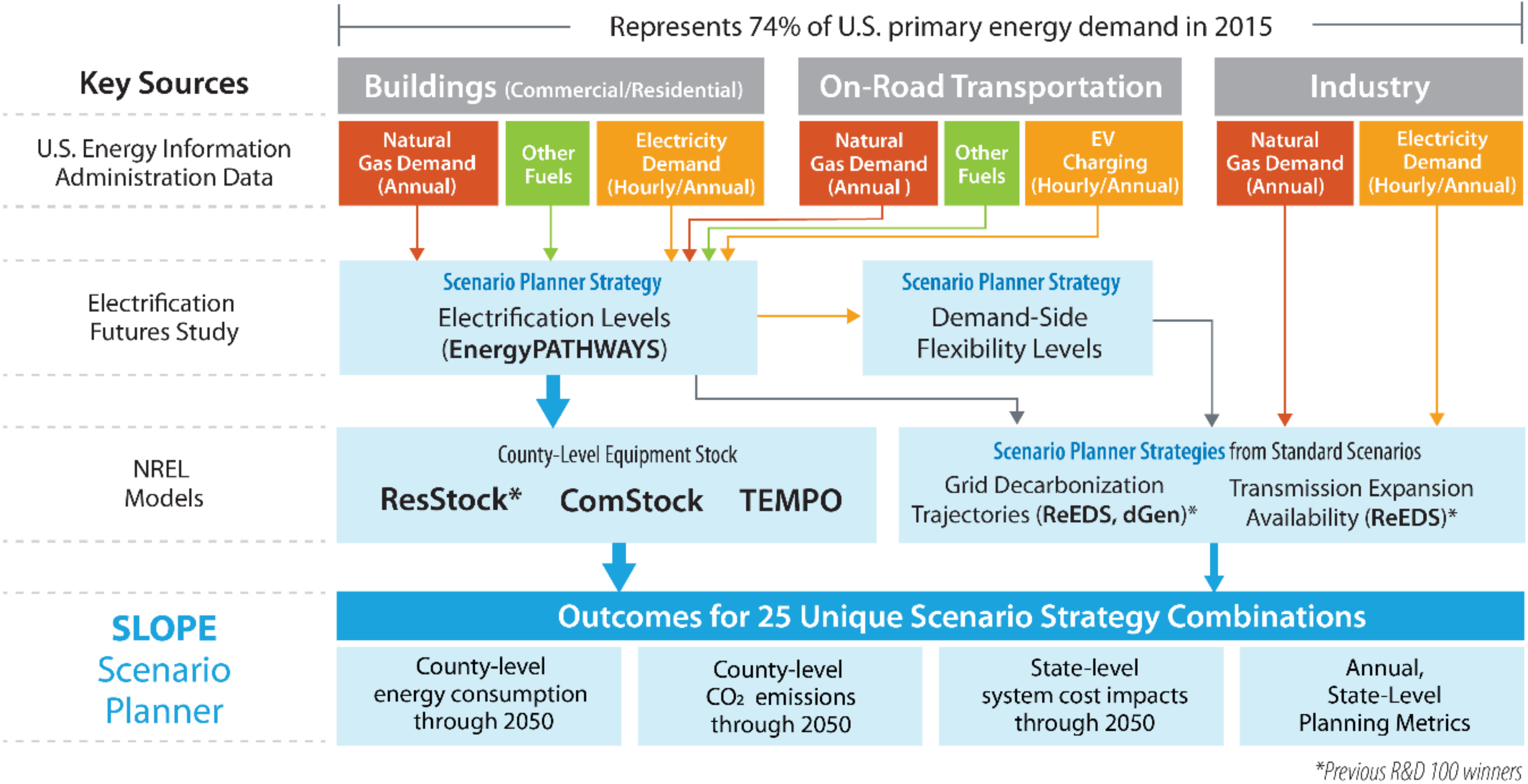
Transportation Energy & Mobillity Pathway Options™ (TEMPO)

Electrification Futures Study



2021 Standard Scenarios

Scenario Planner: Analysis Architecture



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Data Viewer

SLOPE Data Viewer

Consumption

What sectors (e.g., commercial, industrial, residential) should my city focus on to have the biggest impact on reducing greenhouse gas emissions?

Efficiency

What is the energy efficiency savings potential in my jurisdiction, and what are the most cost-effective savings measures in my state?

System Costs and CO_2 Emissions

How do the system cost and emission impacts of various energy strategies compare?

Buildings

How many commercial buildings over 20,000 ft^2 are in my city, and what is the total square footage broken down by property type?

Renewables

How much of my county's energy consumption can be met by locally generated renewable energy?

Sustainable Transportation

How might the number of electric vehicles (EVs), conventional gasoline, hybrid gasoline, and plug-in hybrid EV personal vehicles change in the future?

Cost of Energy

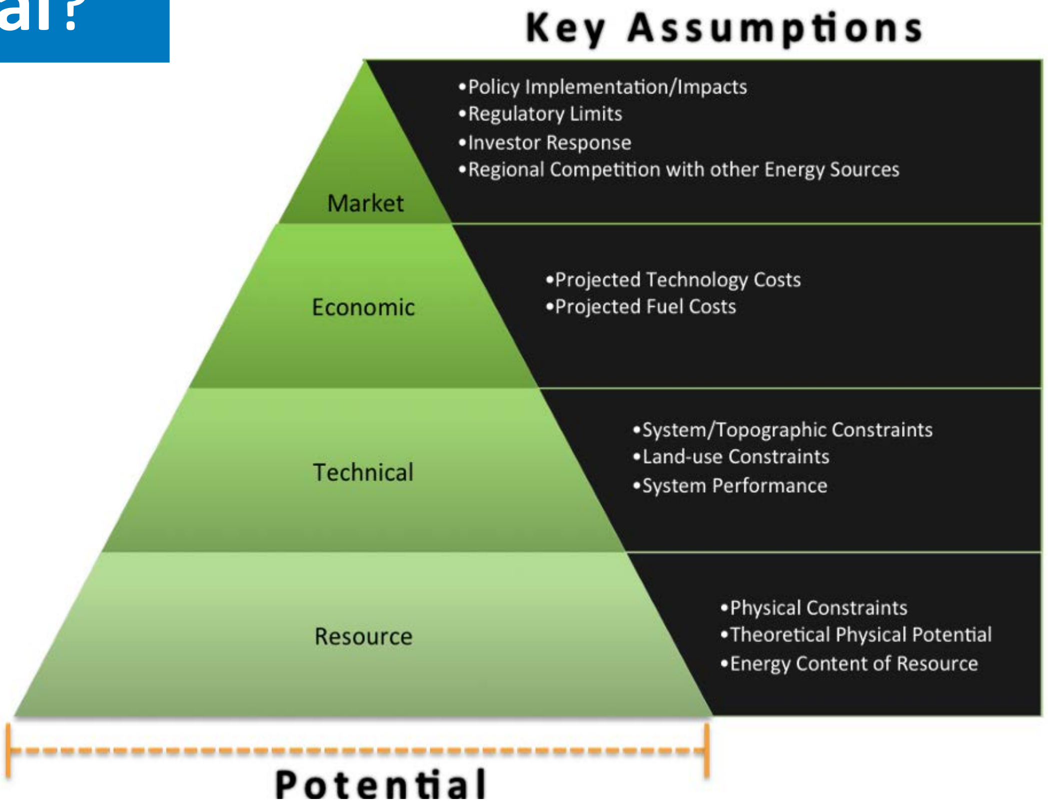
How do the costs of utility-scale and distributed renewables, fossil fuels, energy storage, and efficiency compare in my jurisdiction?

Decarbonization Planning

How can various energy strategies help my community achieve its decarbonization goals?

What Is **Technical Generation Potential?**

The **technical generation potential** of a renewable technology is an **upper bound** of **achievable energy generation** given system **performance**, **topographic**, **environmental**, and **land-use** constraints.



Source: Lopez et al., 2012. NREL. *U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis*. www.nrel.gov/docs/fy12osti/51946.pdf.

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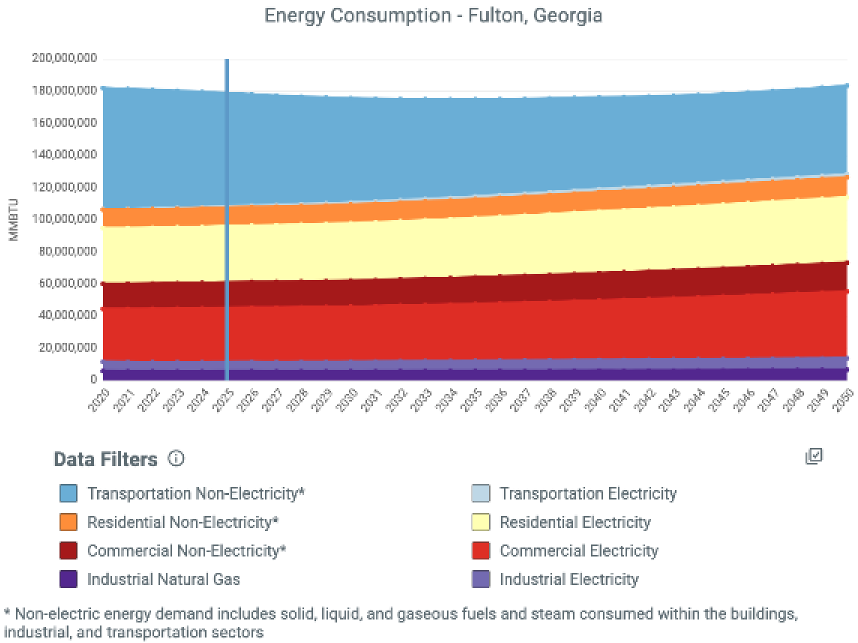
Scenario Planner and Data Viewer: Live Demo

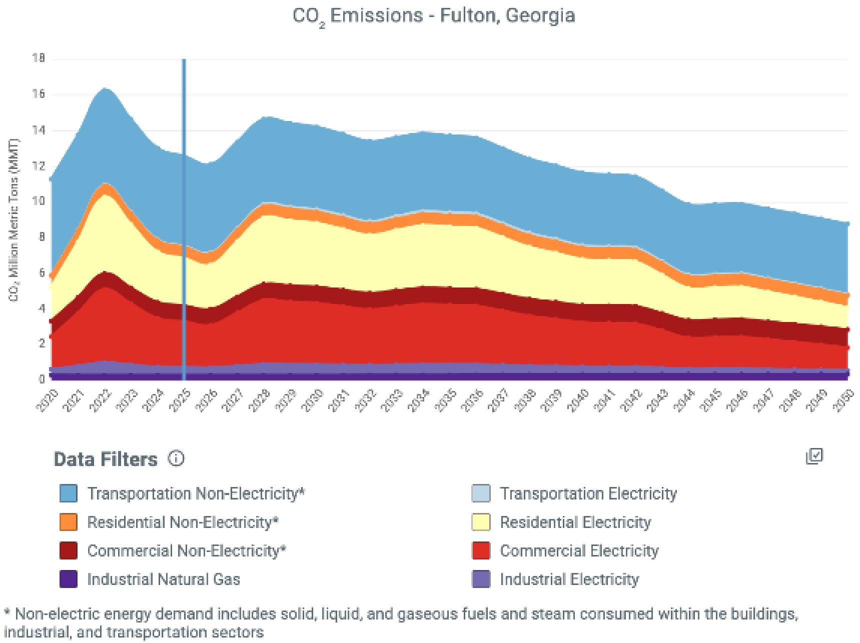
SLOPE Scenario Planner

Scenario 1: Reference Case



Transportation fuels and residential and commercial electricity consumption generate ~80% of carbon emissions in Fulton County, GA.

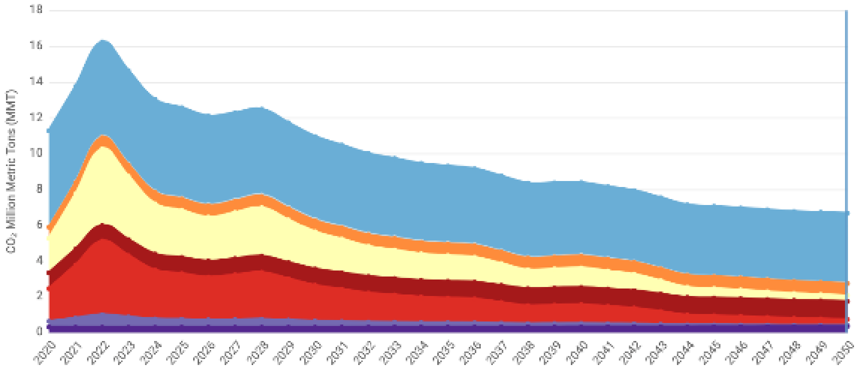
Scenario 2: Reference Case



The 2050 business-as-usual scenario projects a 22% emissions reduction from 2020 levels.

Scenario 1: 95% Grid Decarbonization by 2050

CO$_2$ Emissions - Fulton, Georgia



Data Filters ⓘ

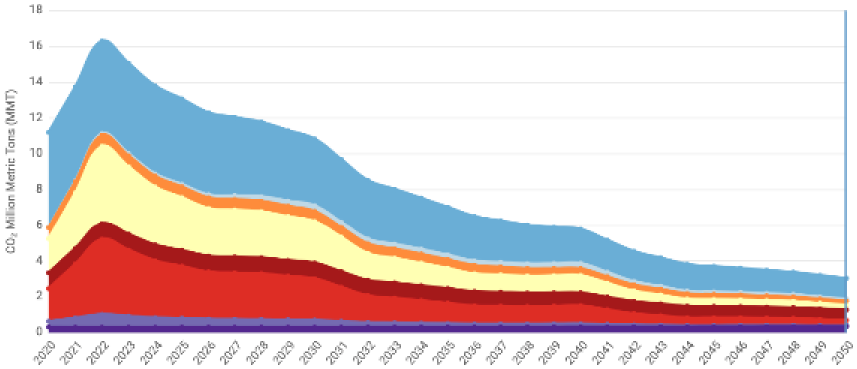
- Transportation Non-Electricity*
- Transportation Electricity
- Residential Non-Electricity*
- Residential Electricity
- Commercial Non-Electricity*
- Commercial Electricity
- Industrial Natural Gas
- Industrial Electricity

* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

95% electricity grid decarbonization would reduce emissions by **24% by 2050** relative to reference. Transportation is the most significant remaining contributor to emissions in 2050.

Scenario 2: 95% Grid Decarbonization by 2050 & Widespread Electrification

CO$_2$ Emissions - Fulton, Georgia



Data Filters ⓘ

- Transportation Non-Electricity*
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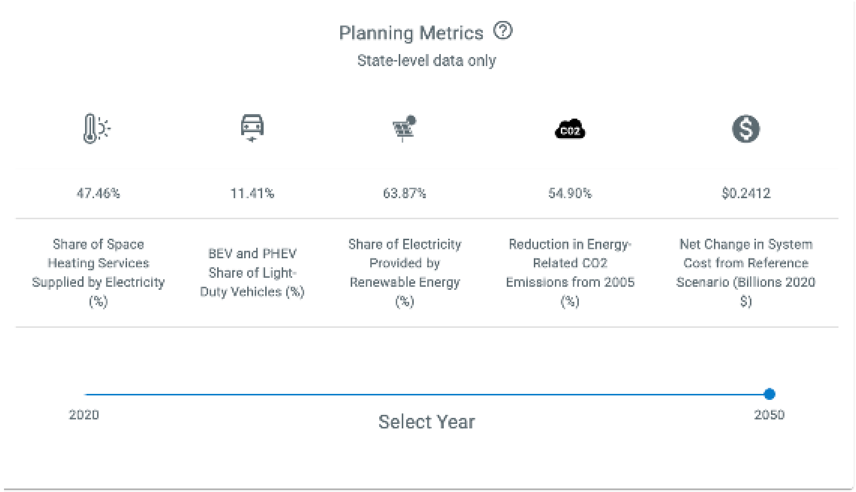
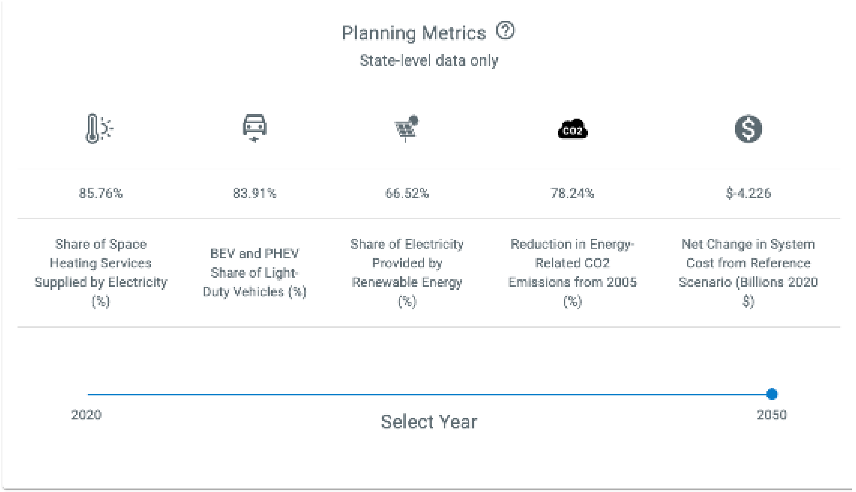
- Residential Non-Electricity*
- Residential Electricity
- Commercial Non-Electricity*
- Commercial Electricity
- Industrial Natural Gas
- Industrial Electricity

* Non-electric energy demand includes solid, liquid, and gaseous fuels and steam consumed within the buildings, industrial, and transportation sectors

Widespread adoption of EVs and electric heating and cooking achieves **75% emissions reductions by 2050** relative to reference.



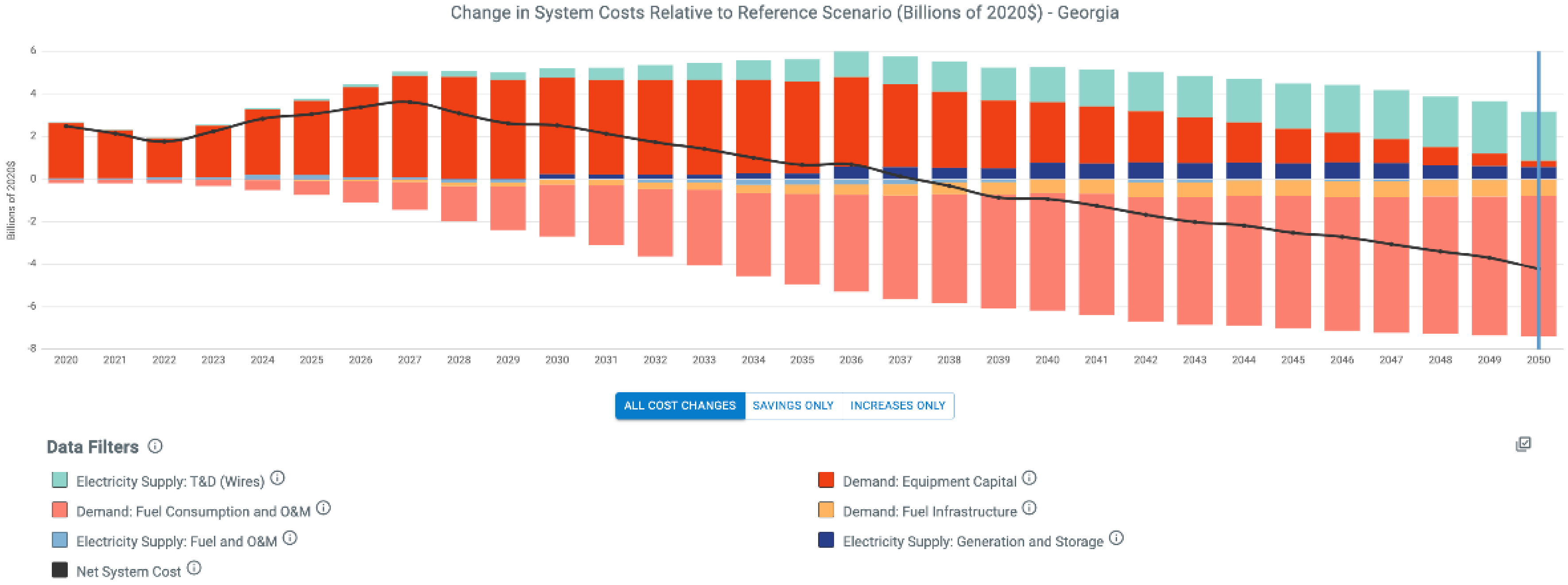
Scenario 1: 95% Grid Decarbonization by 2050



Scenario 2: 95% Grid Decarbonization by 2050 & Widespread Electrification

Under a widespread electrification scenario, **84% of light-duty vehicles are electric** compared to 11% under a reference case in Georgia.

Scenario 1: 95% Grid Decarbonization by 2050 & Widespread Electrification



Net annual savings of widespread electrification plus grid decarbonization begin to be realized in 2037 in Georgia.

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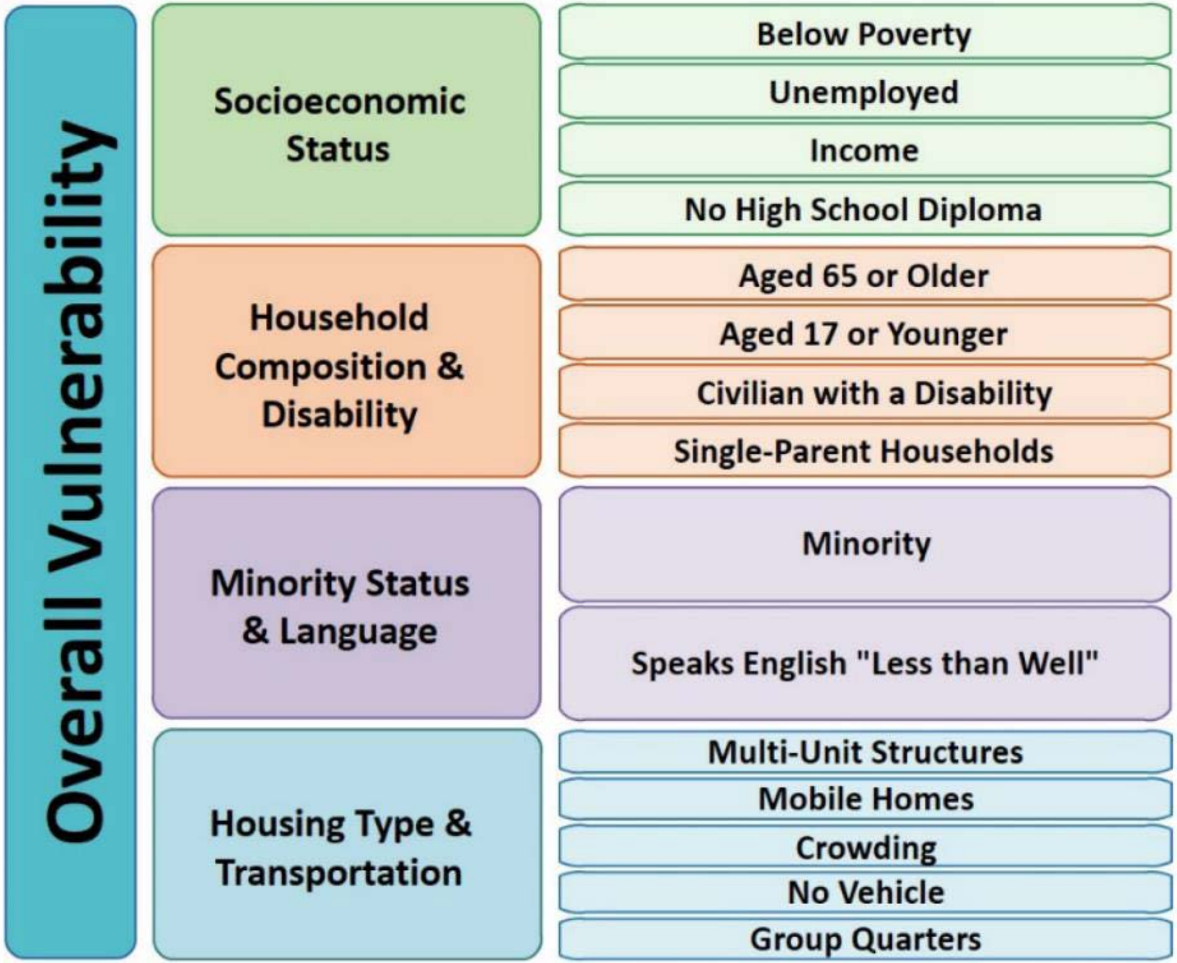
Energy and Environmental Justice Data

Center for Disease Control

Social Vulnerability Index

Variables Used:

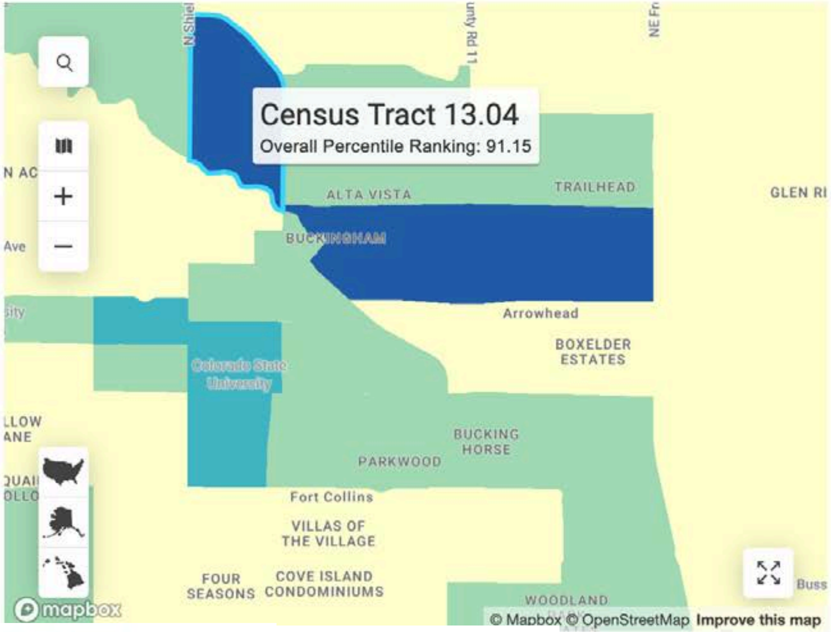
American Community Survey (ACS), 2014-2018 (5-year) data



https://www.atsdr.cdc.gov/placeandhealth/svi/documentation/pdf/SVI2018Documentation_01192022_1.pdf

Which Factors Contribute to Social Vulnerability in Our Community?

Overall Social Vulnerability Index



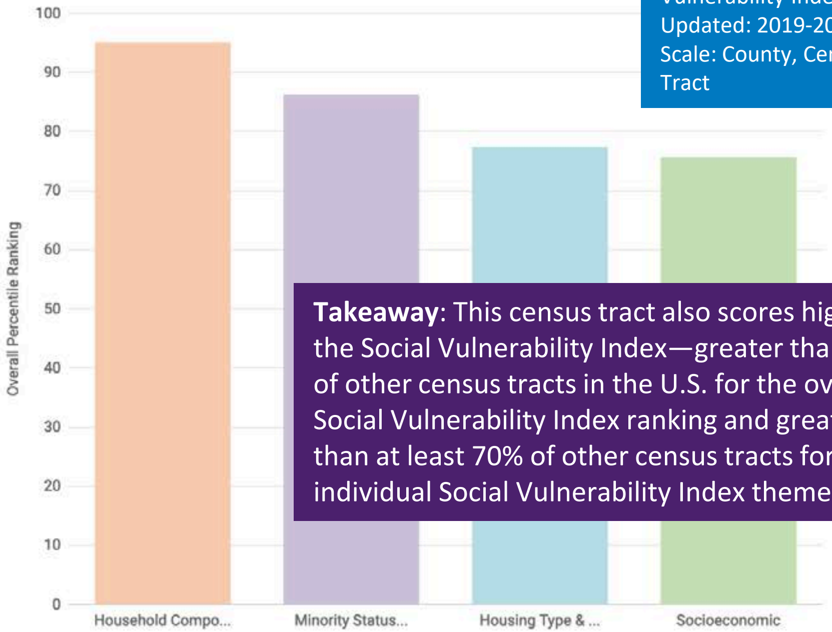
Map Legend

(Overall Percentile Ranking)

- 75+| Highest Vulnerability
- 50 - 75
- 25 - 50
- 0 - 25| Lowest Vulnerability

Social Vulnerability Index Rankings

For Census Tract 13.04



SLOPE Data Viewer, Social Vulnerability Index
Updated: 2019-20
Scale: County, Census Tract

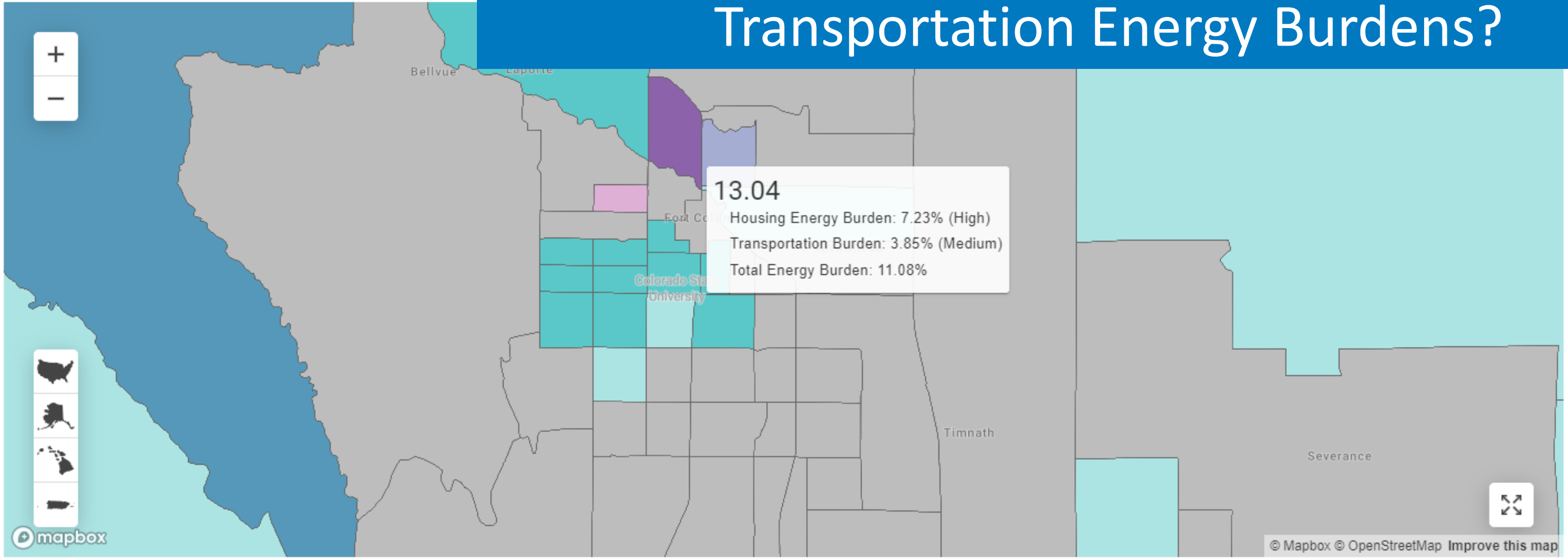
Takeaway: This census tract also scores high on the Social Vulnerability Index—greater than 91% of other census tracts in the U.S. for the overall Social Vulnerability Index ranking and greater than at least 70% of other census tracts for each individual Social Vulnerability Index theme.

Data Filters

- Socioeconomic
- Household Composition & Disability
- Minority Status & Language
- Housing Type & Transportation

Which Communities Experience High Household Transportation Energy Burdens?

Household Energy and Transportation Burden



Map Legend

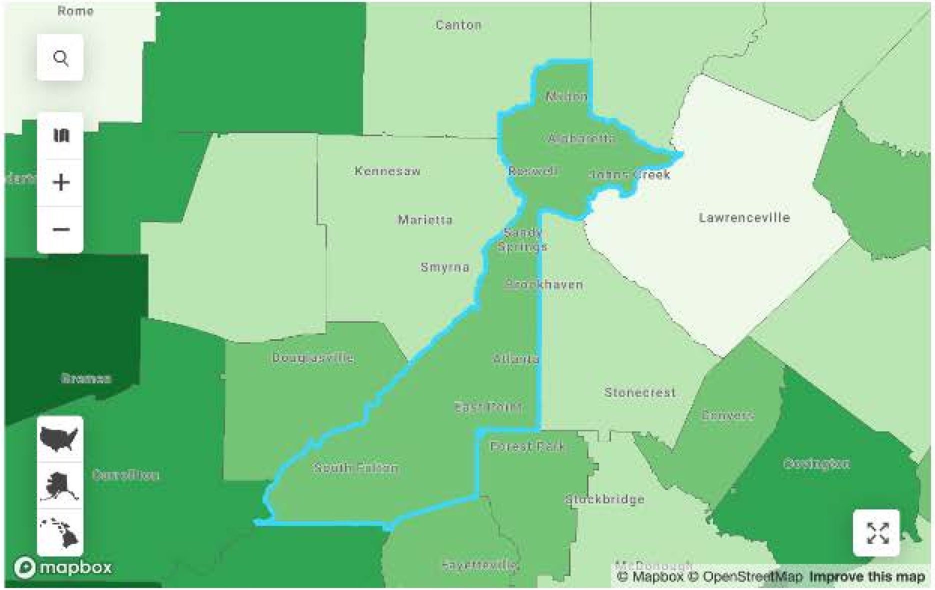
(Percent of Income)

	Low	Medium	High
Housing Energy Burden	< 3.8 %	3.8 - 6.0 %	> 6.0 %
Transportation Burden	< 3.6 %	3.6 - 4.2 %	> 4.2 %

Some census tracts experience high housing energy burdens, paying more than 6% of annual household income on energy bills. SLOPE identifies where housing energy burdens overlap with high transportation energy burdens. Programs and infrastructure investments could help alleviate energy and transportation costs for low-income households in these areas.

How Can Energy Efficiency Lower Bills for Low-to-Moderate Income Single-Family Homes in Our County?

Average % Bill Savings in LMI Households Eligible for Efficiency Upgrade Package



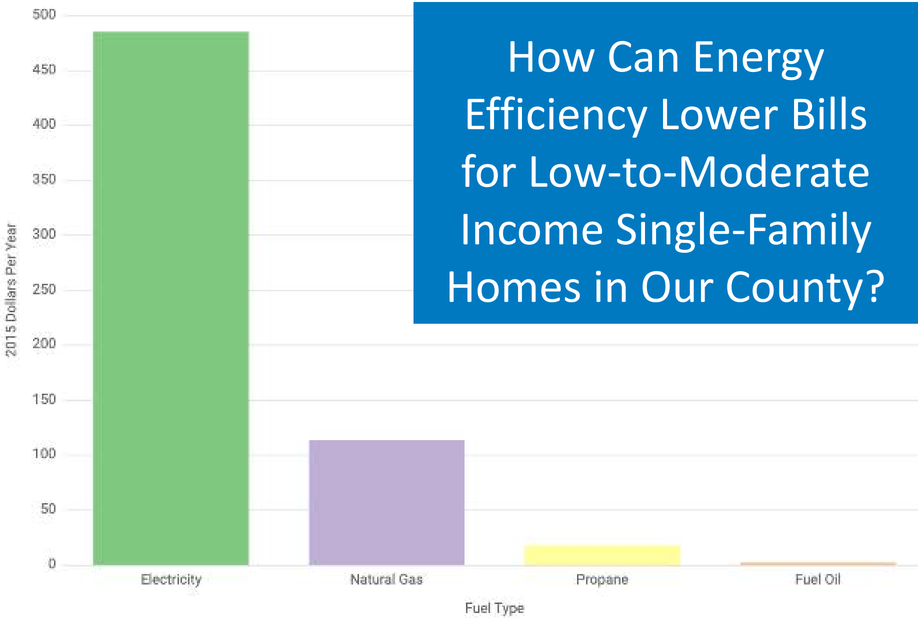
Map & Graph Resolution: County **State:** Georgia **County:** Fulton

Map Legend

(Average % Bill Savings)

- 51 +
- 45 - 51
- 40 - 45
- 35 - 40
- 0 - 35

Annual Energy Bill Savings Per LMI Single Family Home



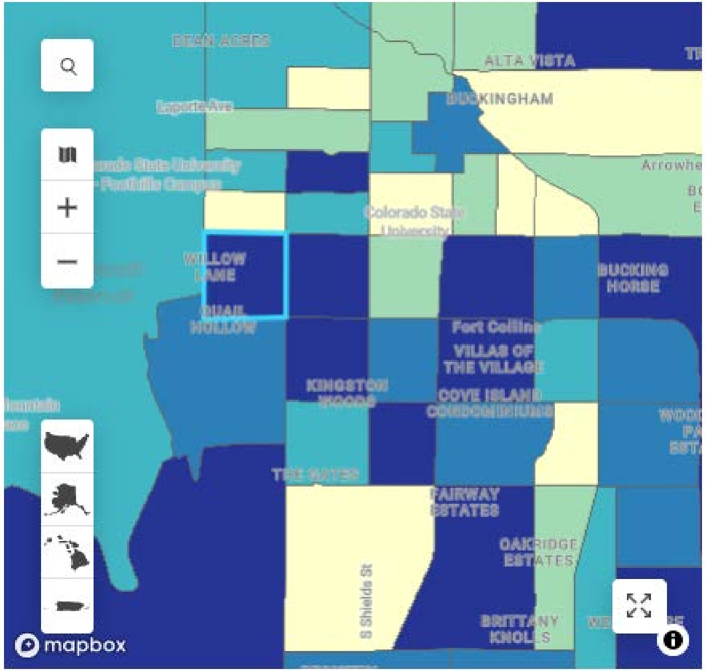
Data Filters

- Electricity
- Natural Gas
- Fuel Oil
- Propane

Low-to-moderate income households in Fulton County, Georgia that implement cost-effective energy efficiency upgrades can save up to **41%** on energy bills.

The highest savings would come from annual electricity savings of **$485**, followed by $114 annual savings potential on natural gas.

Which Neighborhoods May Face Additional Barriers to Clean Energy Access or Experience Disproportionate Burdens from the Energy System?



Map & Graph Resolution: 2020 Census Tracts **State:** Colorado

County: Larimer **Census Tract:** 11. **Year:** 2020

Map Legend

(Count of LMI Households)

- 830+
- 660 - 830
- 528 - 660
- 391 - 528
- 0 - 391

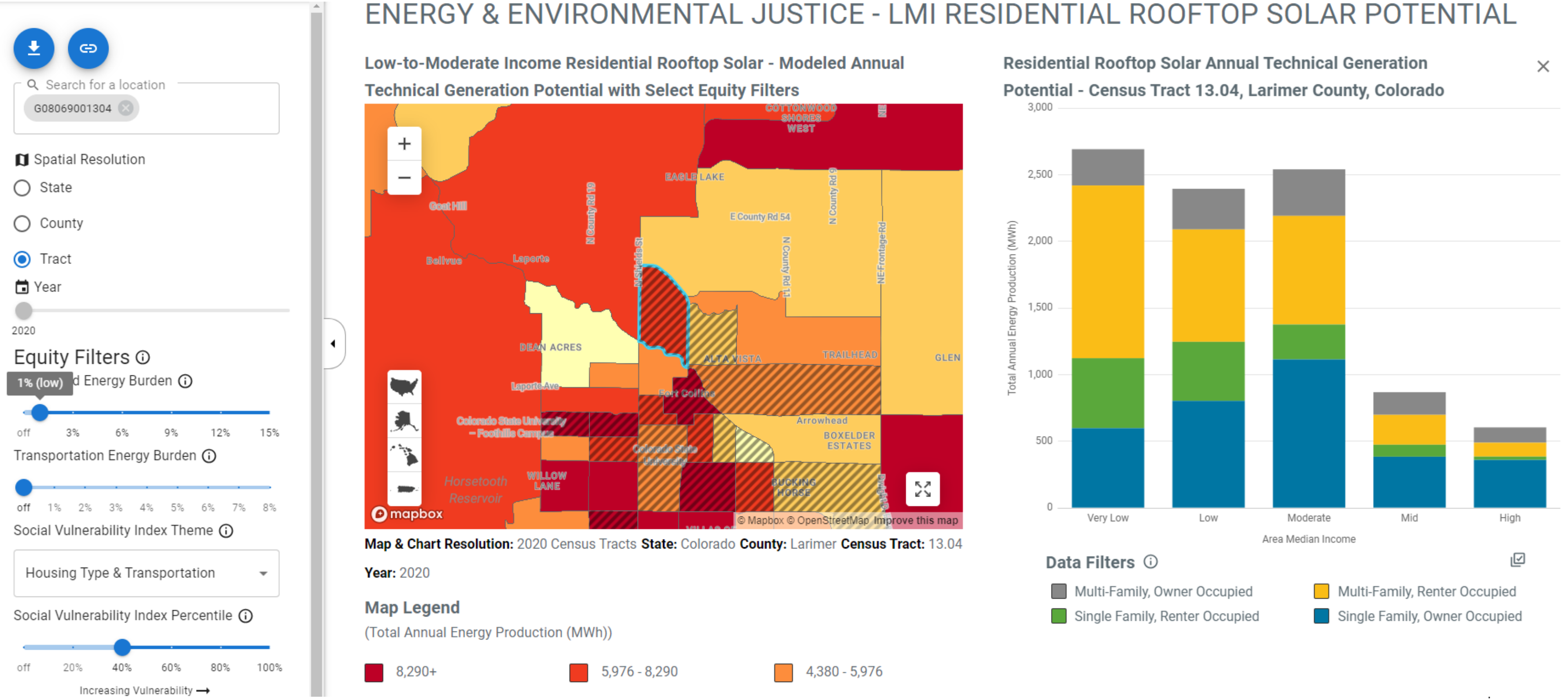
Demographic Information - Census Tract 11.04, Larimer County, Colorado

Underserved Community Status	
DOE-defined Disadvantaged Community	No
Disadvantaged Community Score	0
Population and Demographics	
Total Population	6,229
Total Number of Households	2,350
Average Household Size	2.47 people
Percent of Population Identified as American Indian and Alaska Native	1.08%
Percent of Population Identified as Asian	1.04%
Percent of Population Identified as Black or African American	0%
Percent of Population Identified as Hispanic or Latino	8.8%
Percent of Population Identified as Multiracial	4.96%
Percent of Population Identified as Native Hawaiian and Pacific Islander	0.18%
Percent of Population Identified as Other	0%
Percent of Population Identified as White	83.95%
Census Tract Majority Racial Group	White

Housing	
Percent of Overcrowded Households	0%
Residential Rental Vacancy Rate	0%
Homeowner Vacancy Rate	0%
Percent of Households in Multifamily Buildings	17.57%
Average Housing Build Year	1982
Median Home Value	$378,800
Economy and Jobs	
Percent Unemployment	27.98%
Number of Low-to-Moderate Income Households (0-80% AMI)	965
Percent Households With Low-to-Moderate Income	41.06%
Health, Age and Disability	
Percent Of Population Under 5 Years Old	5.23%
Percent Of Population Over 64 Years Old	9.73%
Percent of Population with a Disability	9.28%
Education and Language	
Percent of Population with Less Than High School Education	1.68%
Percent of Adults with Language Barriers	2.83%
Transportation	
Percent of Households with No Vehicles Available	2.09%

Takeaway: The U.S. Department of Energy uses 36 burden indicators to calculate disadvantaged community status, reflecting fossil fuel dependence, energy burden, environmental and climate hazards, and socioeconomic vulnerabilities. This census tract has a high number and percentage of low-to-moderate income households.

How Can Rooftop Solar Investments and Programs Serve Low-Income Communities?



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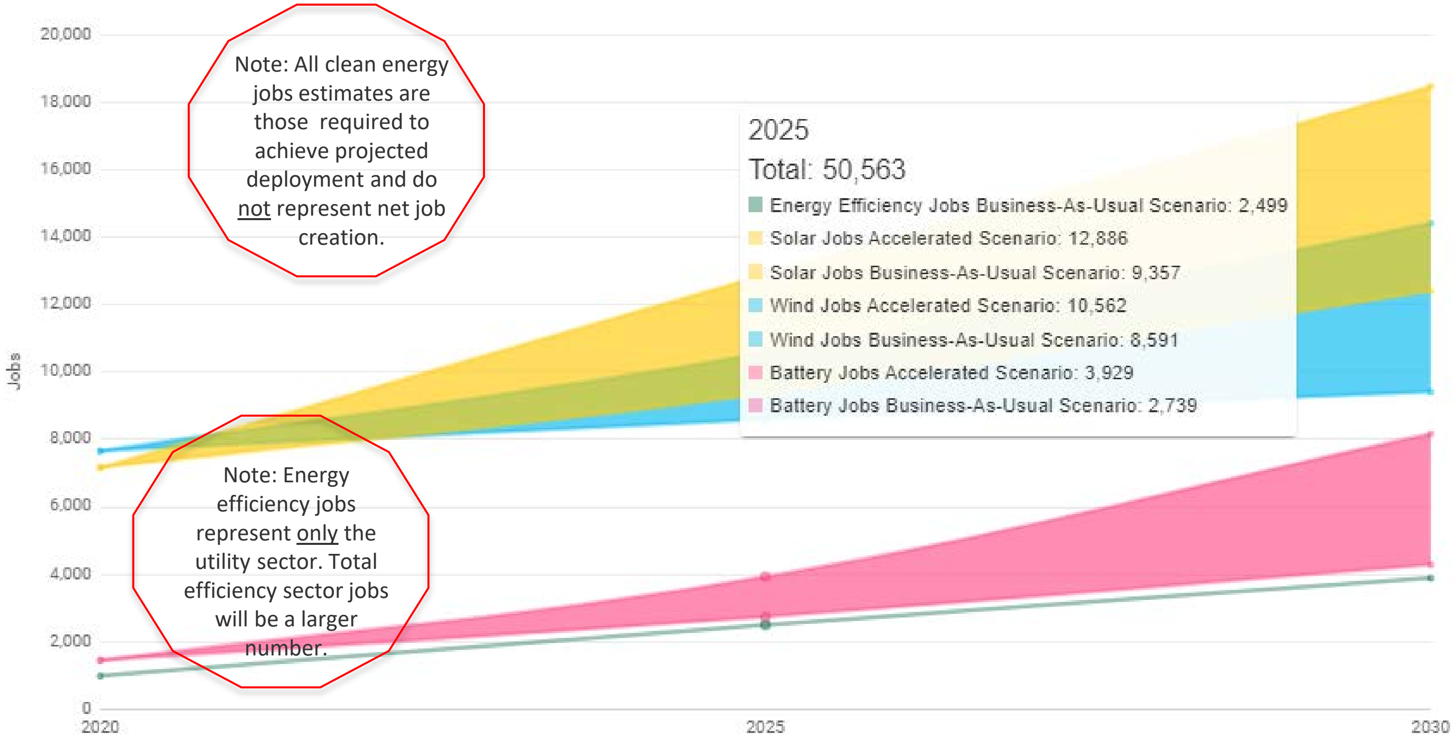
Economic Indicators – Clean Energy Jobs

Which Clean Energy Jobs Will Increase the Most in My State?

Clean Energy Jobs Estimates by Technology - Colorado



Takeaway: In Colorado, solar energy jobs are projected to increase the most. Increasing job training and education, particularly in communities with underemployment or high unemployment and high solar generation potential, can boost local economic development.

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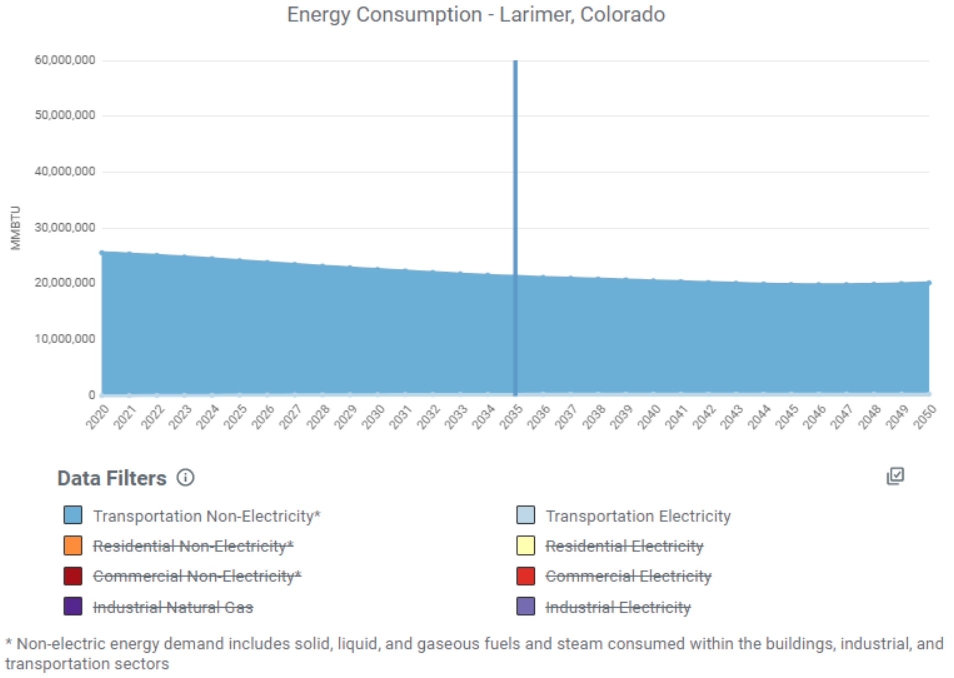
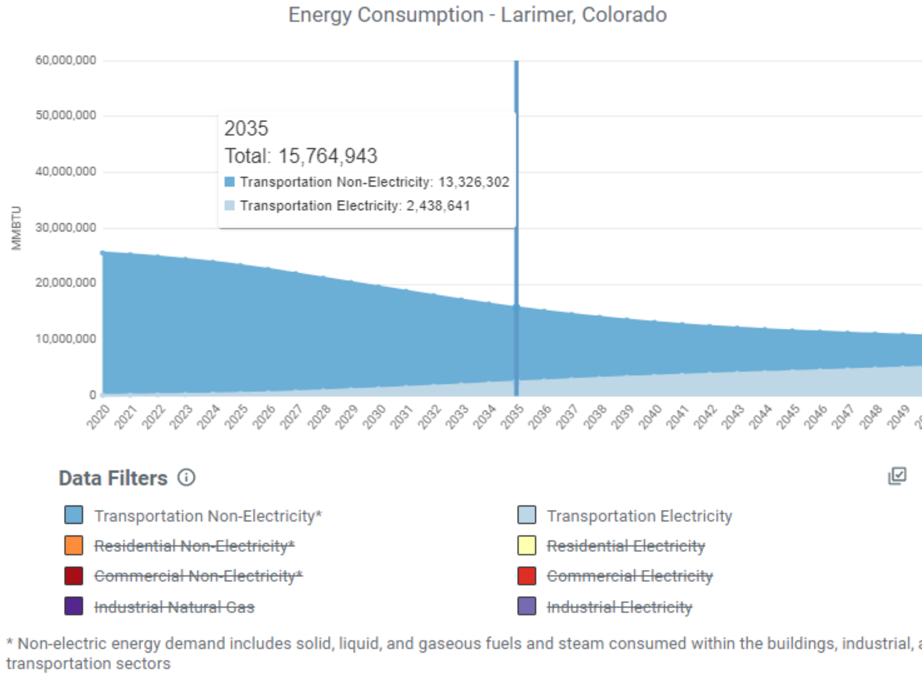
Sustainable Transportation Data

How Will Energy Use for Transportation Change if Our Community Adopts EVs?

Scenario 1: Reference Case



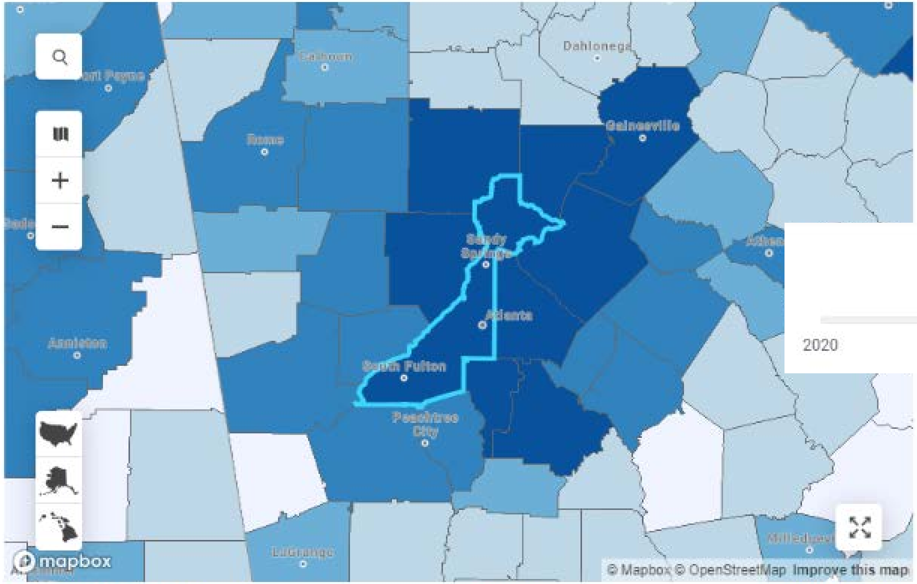
Scenario 2: Widespread Electrification

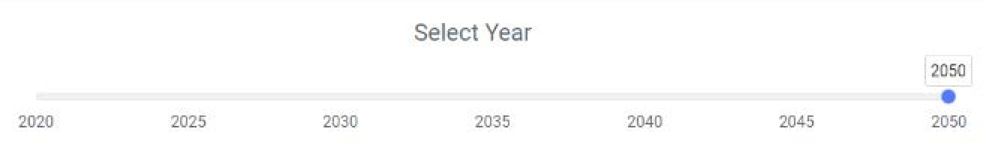


Takeaway: Widespread adoption of EVs in Larimer County could reduce the total energy demand by more than 7 million MMBTU (36%) in 2040 with the same number of cars on the road due to the higher efficiency of EVs.

EV Adoption Scenarios, Fulton County, GA

Personally Owned Light Duty Vehicle Stock - High Electrification





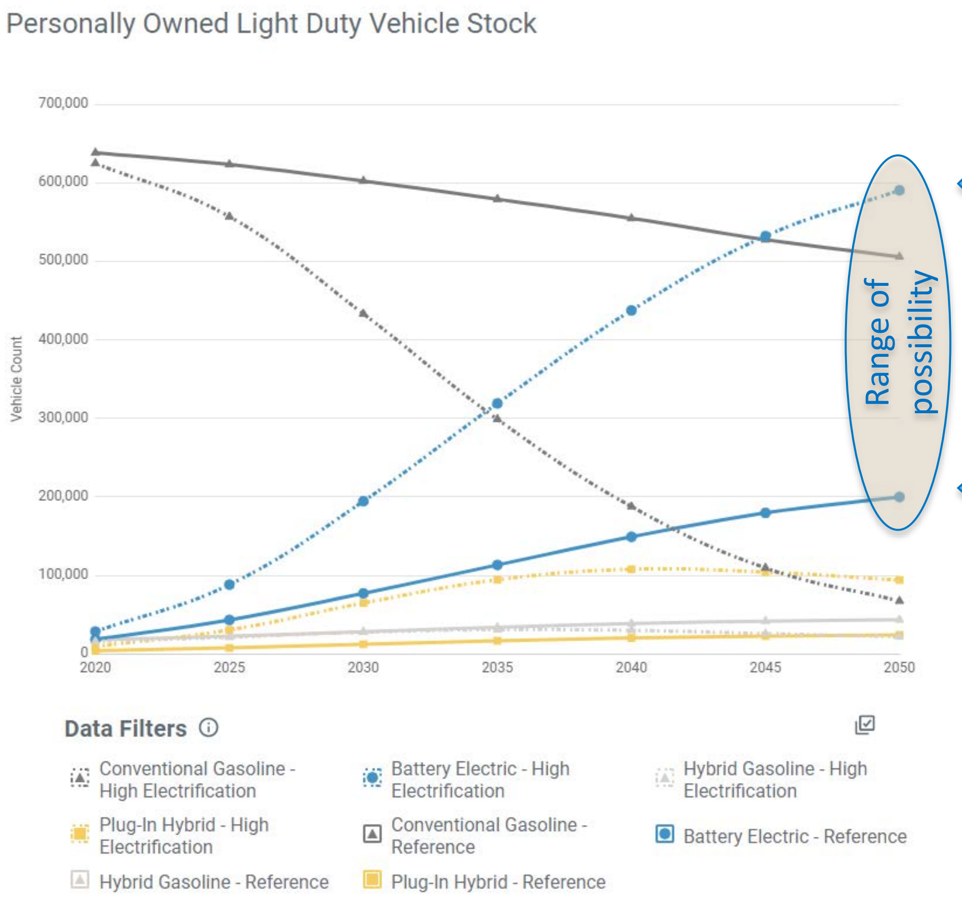
Map & Graph Resolution: County **State:** Georgia **County:** Fulton

Map Legend

(Vehicle Count)

- 162,521+
- 65,574 - 162,521
- 34,234 - 65,574
- 16,293 - 34,234
- 0 - 16,293

What Might EV Adoption Trends Look Like in Our County?

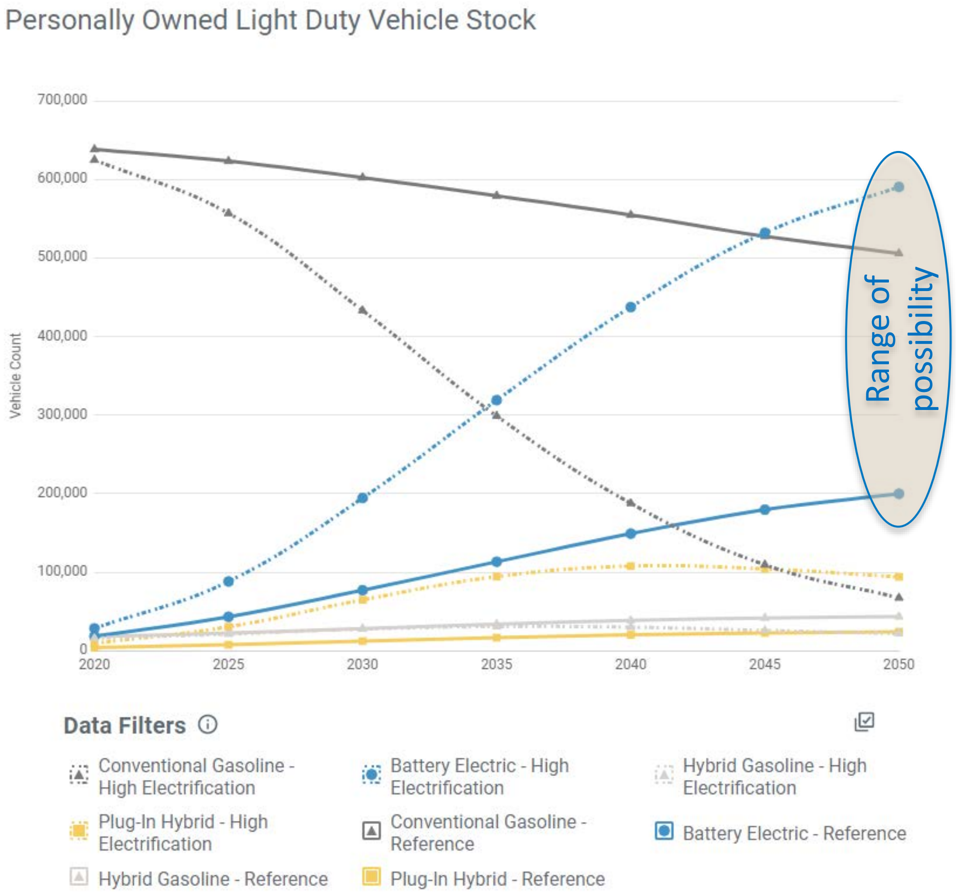


Under a high electrification scenario, Fulton County could see up to 590,573 personally owned EVs by 2050.

Difference of 390,687 EVs

Under a reference/business-as-usual case, the county could see 199,886 personally owned EVs by 2050.

What Level of Charging Infrastructure Is Needed To Support Vehicle Electrification?



Charging infrastructure needed to support 590,573 personally owned EVs by 2050

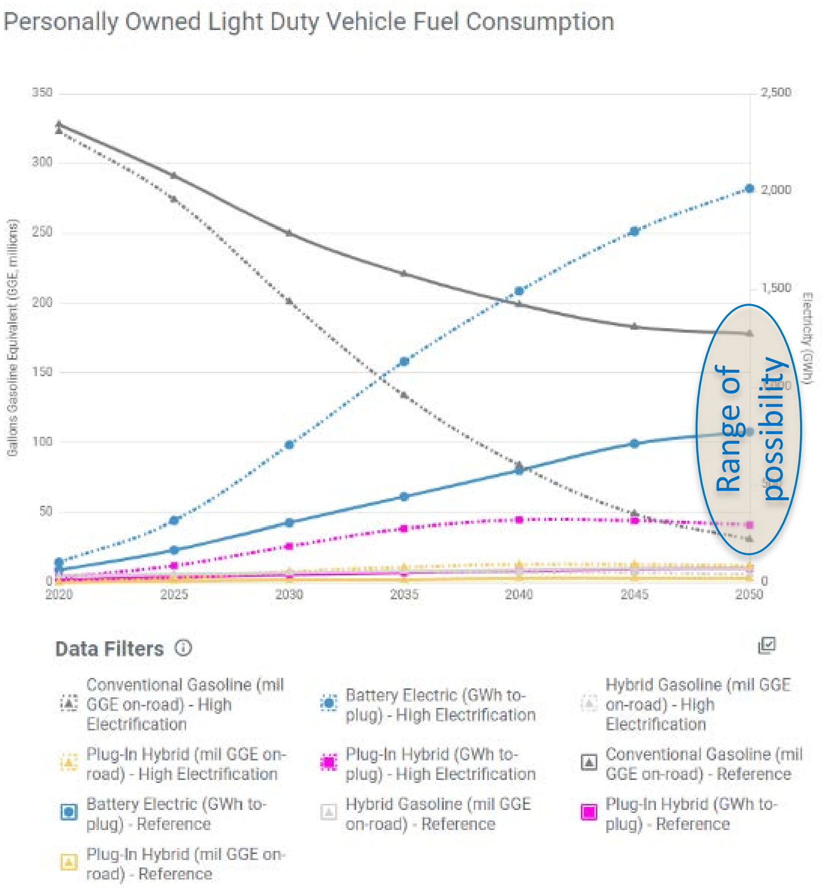
12,314	Workplace Level 2 Charging Plugs
7,293	Public Level 2 Charging Plugs *(Currently 2,100 plugs)*
844	Public DC Fast Charging Plugs *(Currently 366 plugs)*

Charging infrastructure needed to support 199,886 personally owned EVs by 2050

4,484	Workplace Level 2 Charging Plugs
2,768	Public Level 2 Charging Plugs
409	Public DC Fast Charging Plugs

SLOPE Data Viewer: https://maps.nrel.gov/slope/.
EVI-Pro Lite: https://afdc.energy.gov/evi-pro-lite.

How Might Vehicle Electrification Impact Fuel Consumption and Emissions?



Under a high electrification scenario, Fulton County could see **147 million fewer gallons of gasoline** consumed in 2050 than in a reference/business-as-usual scenario.

1.3 million metric tons CO_2 reduction
= carbon reduction from 1.5 million acres U.S. forests

SLOPE Data Viewer: https://maps.nrel.gov/slope/.
EPA Emissions Calculator: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.

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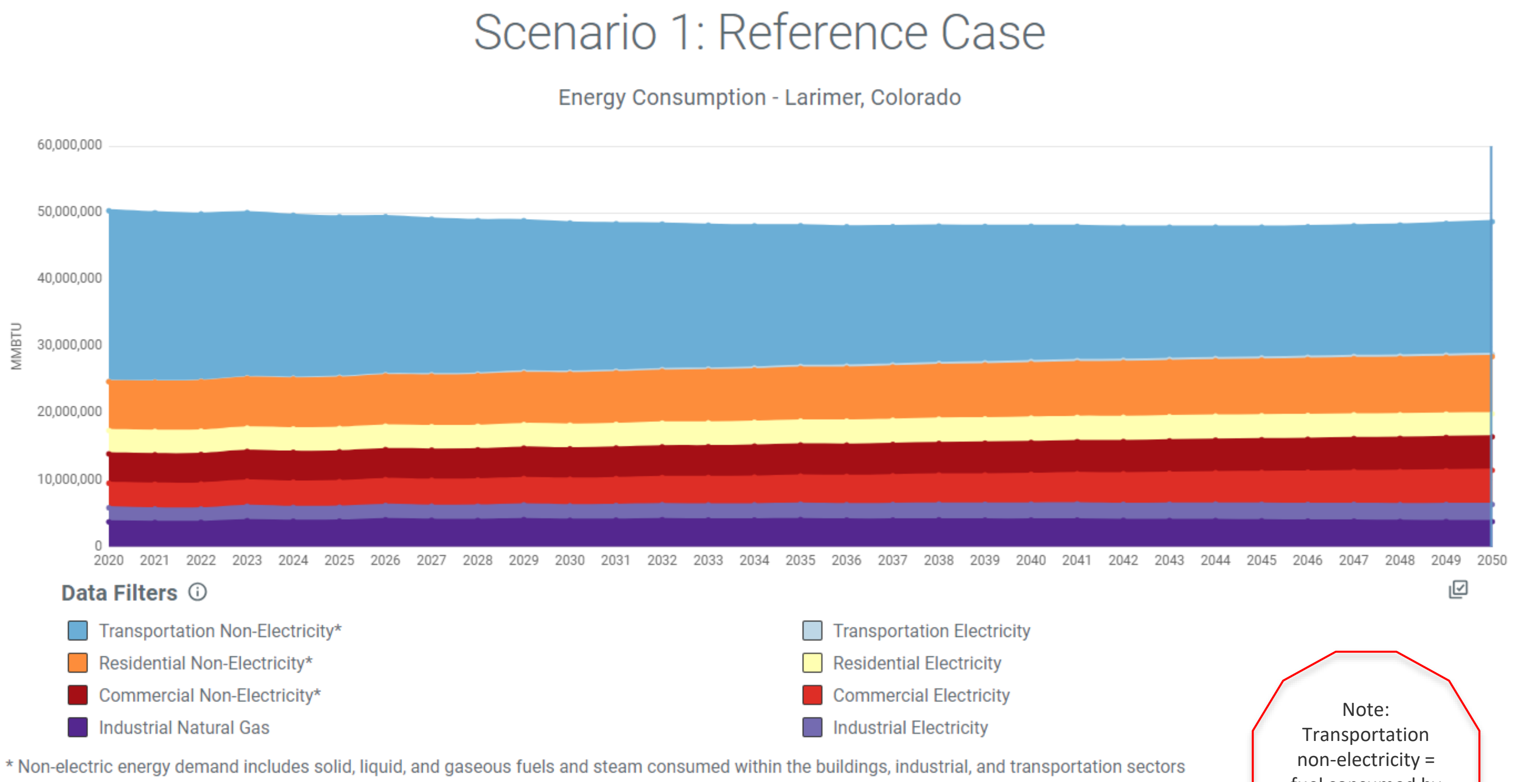
Energy Efficiency Data

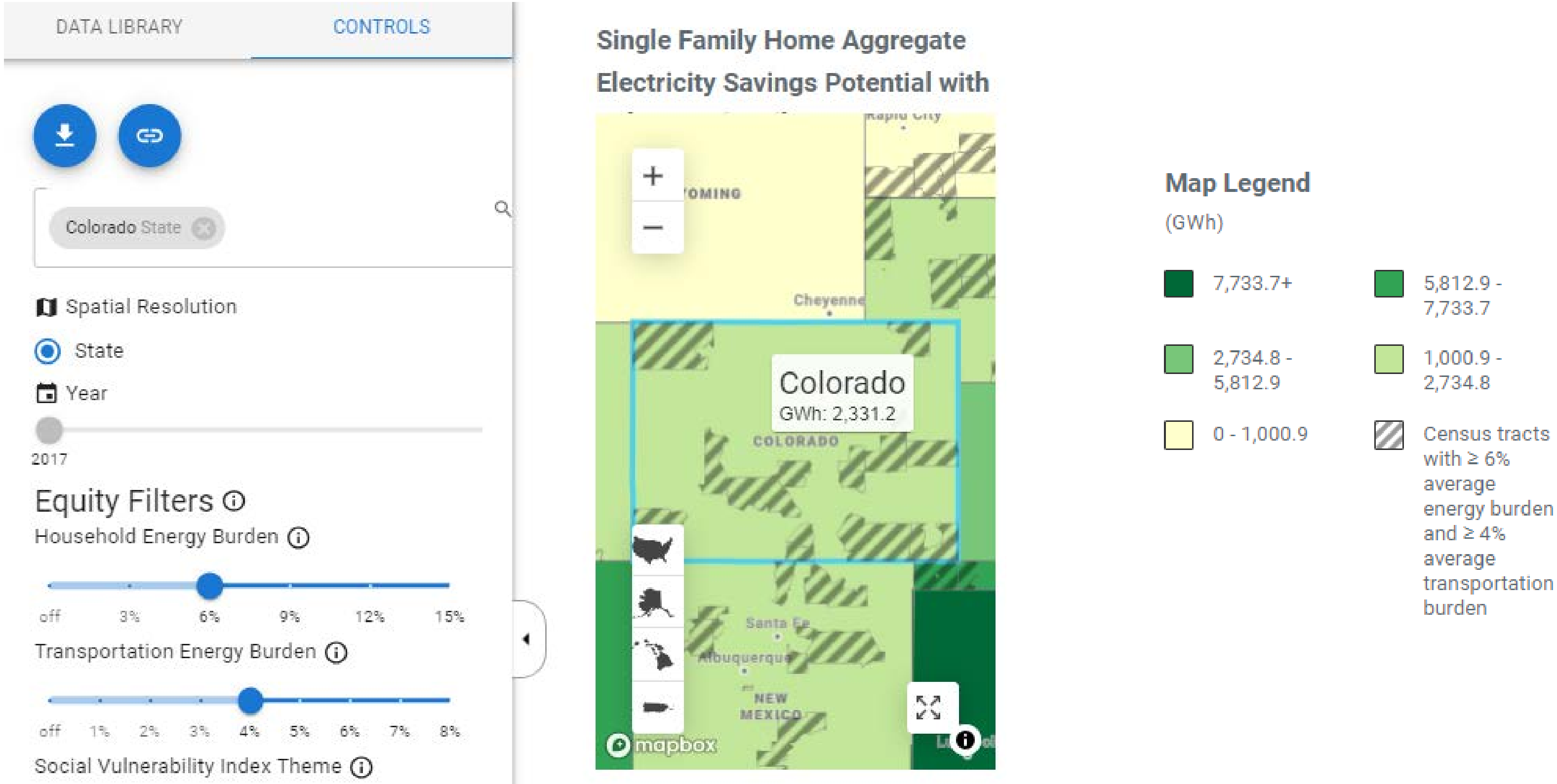
How Much Energy Could We Use in the Future?



Takeaway: Under a business-as-usual/Reference scenario, **on-road vehicles** are expected to remain the largest source of energy demand in Larimer County, CO in 2050.

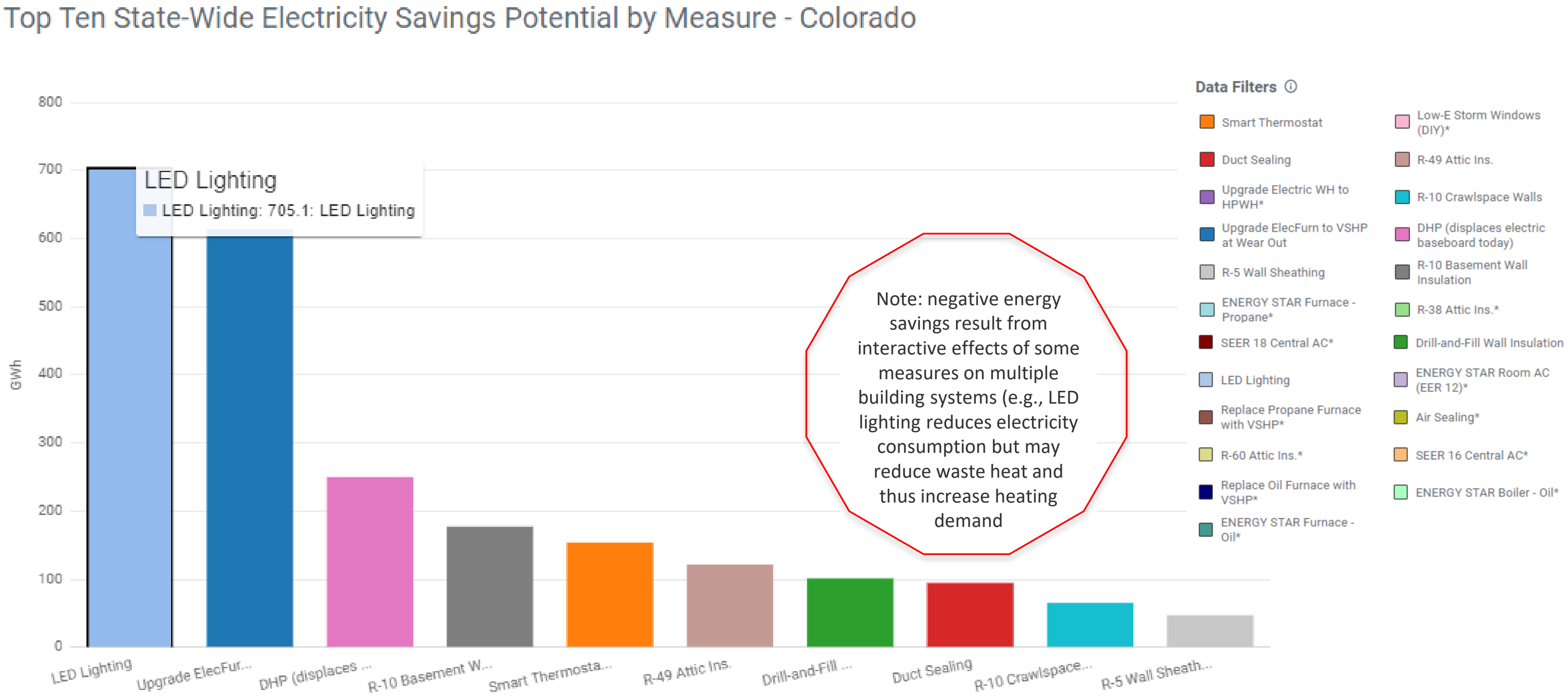
Note: Transportation non-electricity = fuel consumed by on-road vehicles.

How Much Electricity Can Single-Family Homes Save Through Energy Efficiency Measures in Our State?



Takeaway: Cost-effective energy efficiency measures in Colorado single-family homes could reduce annual statewide electricity use by as much as 2,331 GWh.

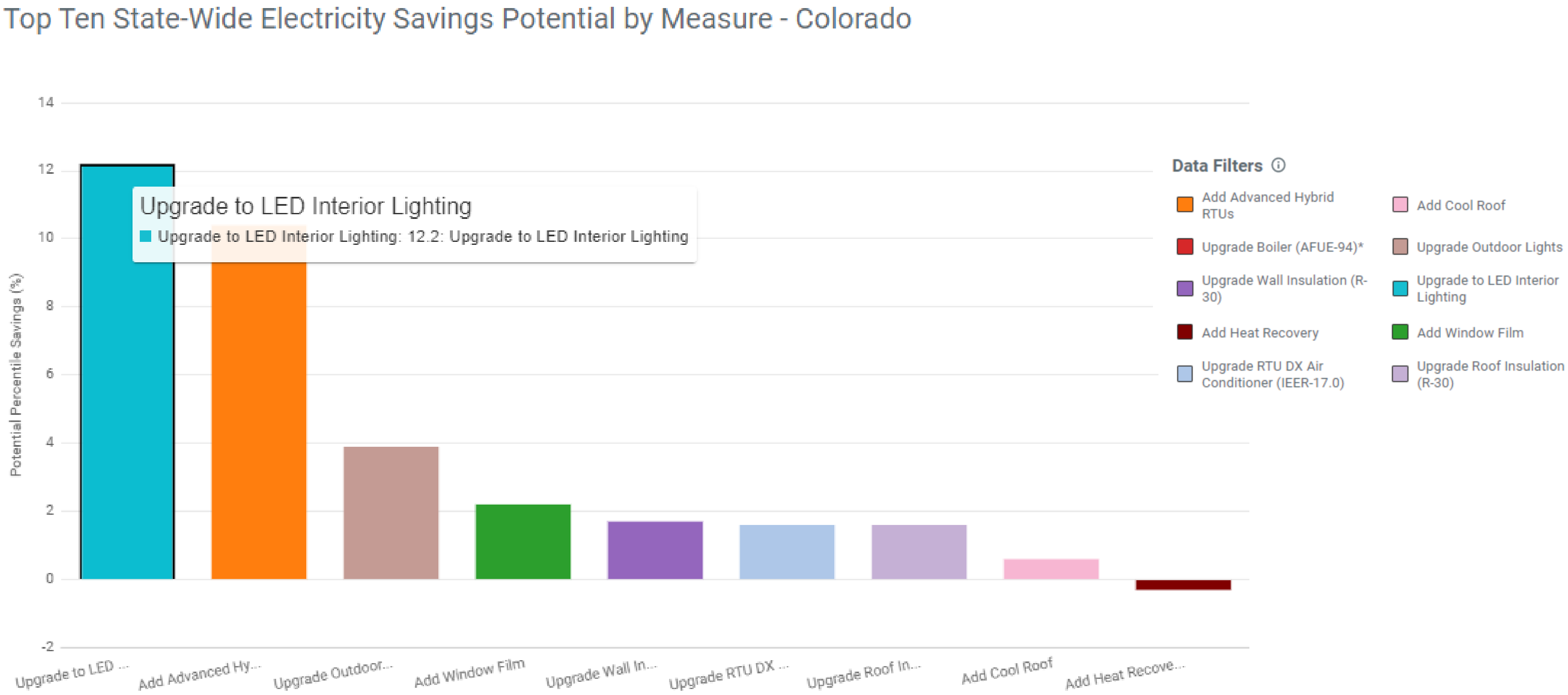
Which Energy Efficiency Measures Could Have the Greatest Impact on Reducing Household Electricity Use in Our State?



Note: negative energy savings result from interactive effects of some measures on multiple building systems (e.g., LED lighting reduces electricity consumption but may reduce waste heat and thus increase heating demand

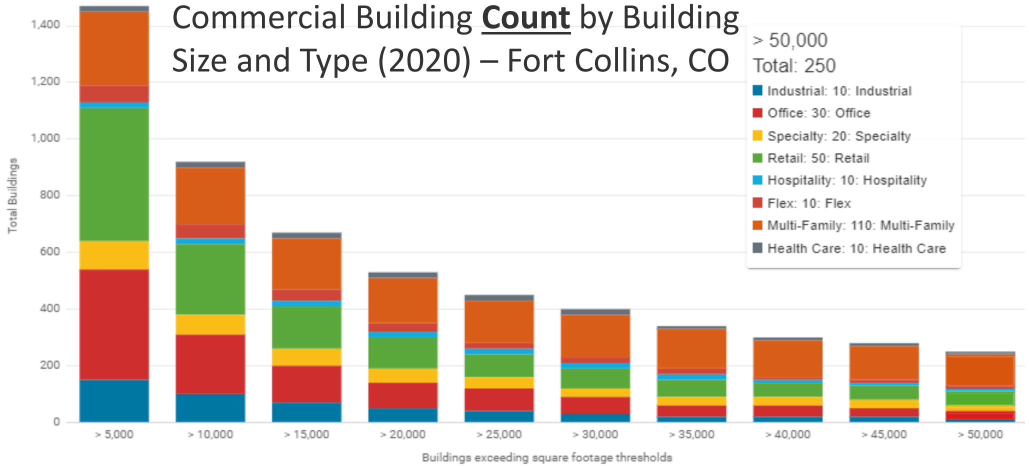
Takeaway: Upgrading to LED lighting and variable speed heat pumps when electric furnaces wear out have the highest residential electricity savings potential in Colorado.

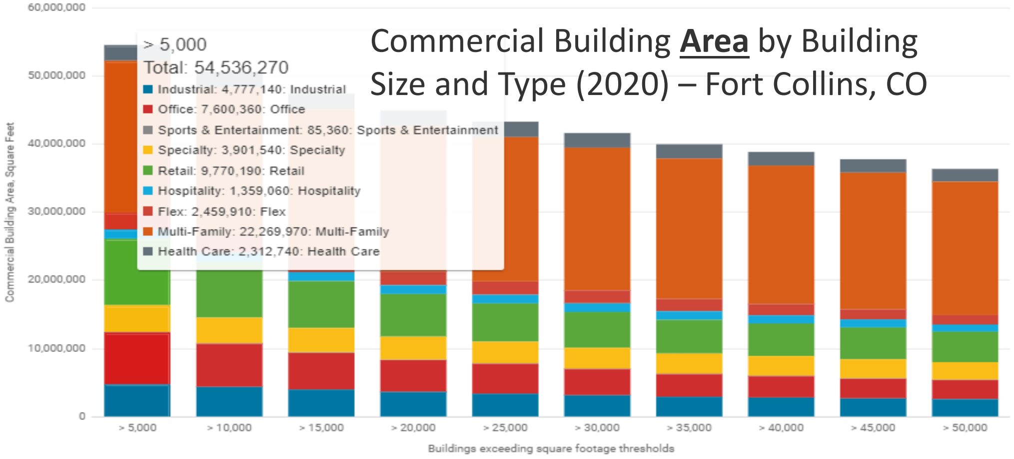
Which Energy Efficiency Measures Could Have the Greatest Impact on Reducing Electricity Use in Commercial Buildings in Our State?



Takeaway: Upgrading to LEDs and adding advanced hybrid rooftop HVAC units in commercial buildings have the greatest cost-effective commercial electricity savings potential in Colorado.

How Can We Design Policies for Our Local Commercial Building Stock?





Takeaway: If Fort Collins established a building energy benchmarking policy for buildings 50,000 sf and larger and included multifamily buildings, it would apply to a majority of the commercial building space in our jurisdiction, while impacting less than 300 buildings, and encourage efficiency upgrades in multifamily housing.

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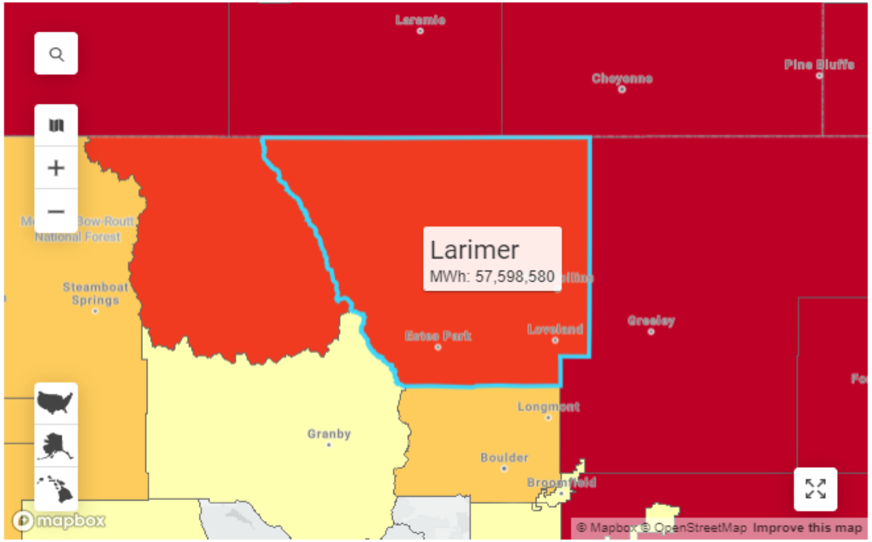
Renewable Energy Data

Which Renewable Energy Technologies Have the Greatest Generation Potential in Our Region?

Modeled Annual Technical Generation Potential - Utility PV



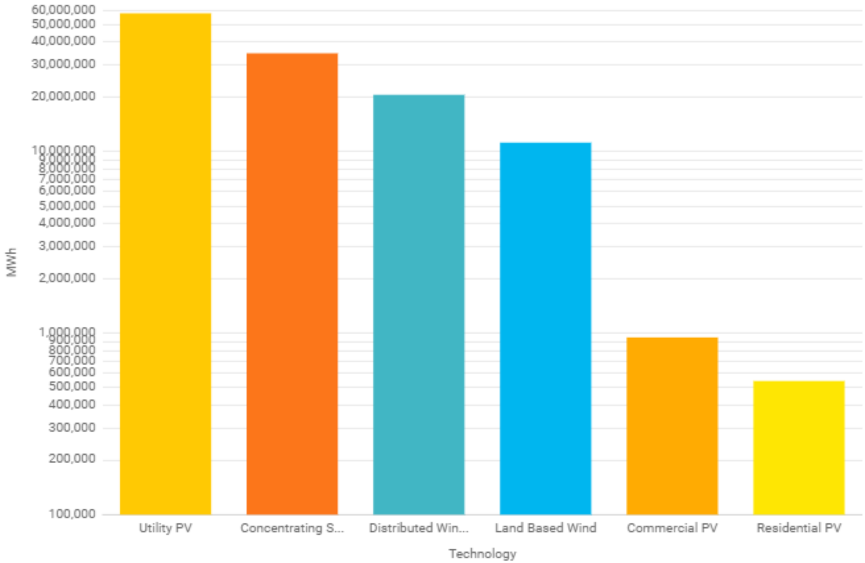
Map & Graph Resolution: County **State:** Colorado **County:** Larimer

Map Legend

(MWh)

- 93,320,770+ MWh
- 55,310,910 - 93,320,770 MWh
- 33,638,270 - 55,310,910 MWh
- 12,432,820 - 33,638,270 MWh
- 0 - 12,432,820 MWh

Annual Technical Generation Potential - Multiple Technologies - Larimer



Data Filters

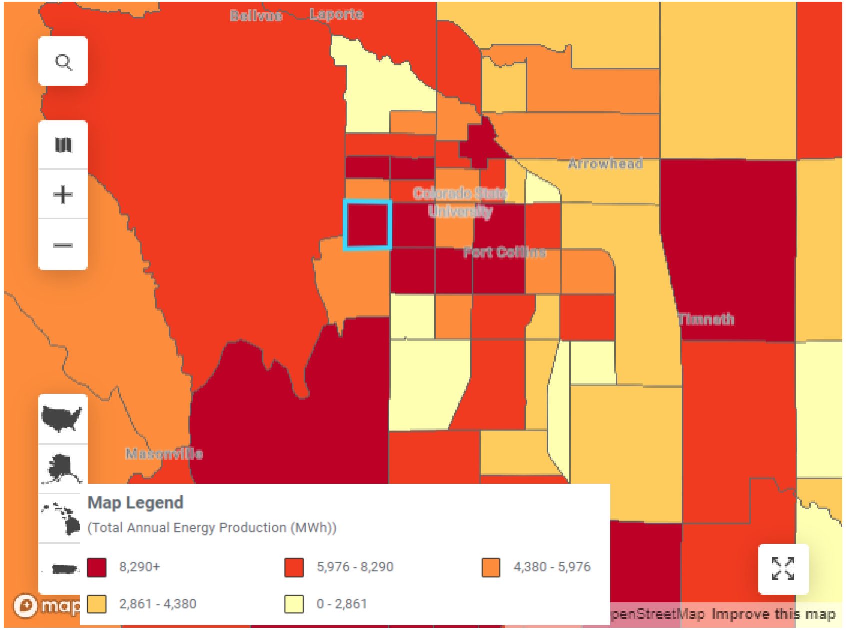
- Land Based Wind Potential
- Concentrating Solar Power Potential
- Hydropower Potential*
- Commercial PV Potential
- Floating PV Potential*
- Offshore Wind Potential*
- Geothermal Potential*
- Distributed Wind Potential
- Biopower Potential*
- Utility PV Potential
- Residential PV Potential

*Category included in map only

Takeaway: Utility solar has the highest technical generation potential in Larimer County, CO. Surrounding counties have higher potential.

How Is Residential Rooftop Solar Potential Distributed Across Residential Buildings by Household Income, Household Tenure, and Building Type?

Low-to-Moderate Income Residential Rooftop Solar - Modeled Annual Technical Generation Potential



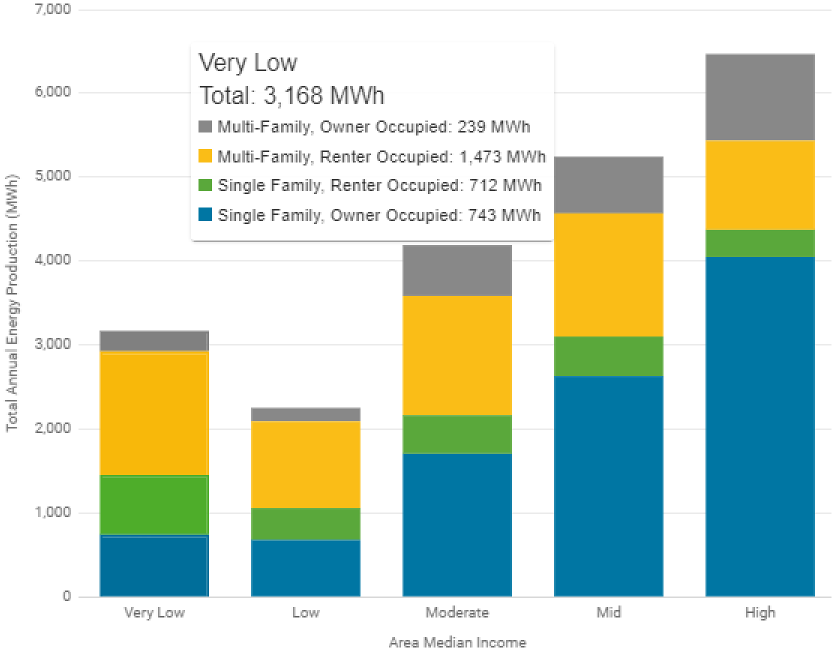
Map & Graph Resolution: 2020 Census Tracts **State:** Colorado **County:** Larimer

Census Tract: 11. **Year:** 2020

Map Legend

(Total Annual Energy Production (MWh))

Residential Rooftop Solar Annual Technical Generation Potential - Census Tract 11.04, Larimer County, Colorado

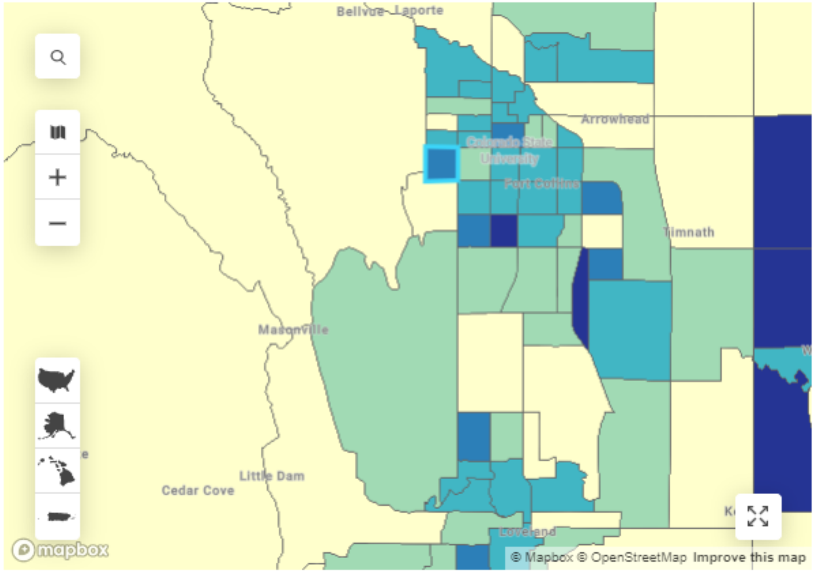


Data Filters

- Multi-Family, Owner Occupied
- Multi-Family, Renter Occupied
- Single Family, Renter Occupied
- Single Family, Owner Occupied

What Portion of Annual Electricity Consumption in Low- and Moderate-Income Households Could Be Offset With Behind-the-Meter Solar?

Low-to-Moderate Income Distributed Residential Solar Offsetable Electricity Consumption



Map & Graph Resolution: 2020 Census Tracts **State:** Colorado **County:** Larimer **Census Tract:** 11.

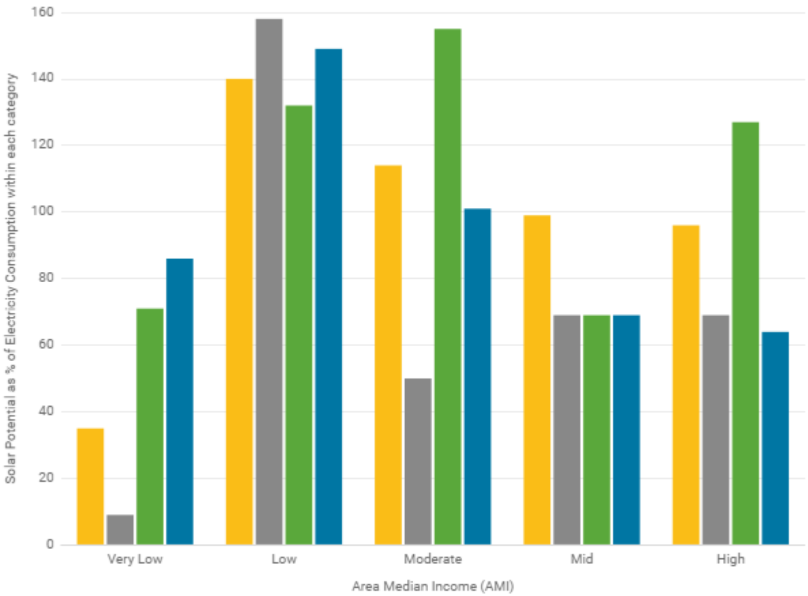
Year: 2020

Map Legend

(Annual Electricity Consumption (%))

- 2,242+
- 1,107 - 2,242
- 588 - 1,107
- 258 - 588
- 0 - 258

LMI Residential Solar Offsetable Electricity Consumption - Census Tract 11.04, Larimer County, Colorado



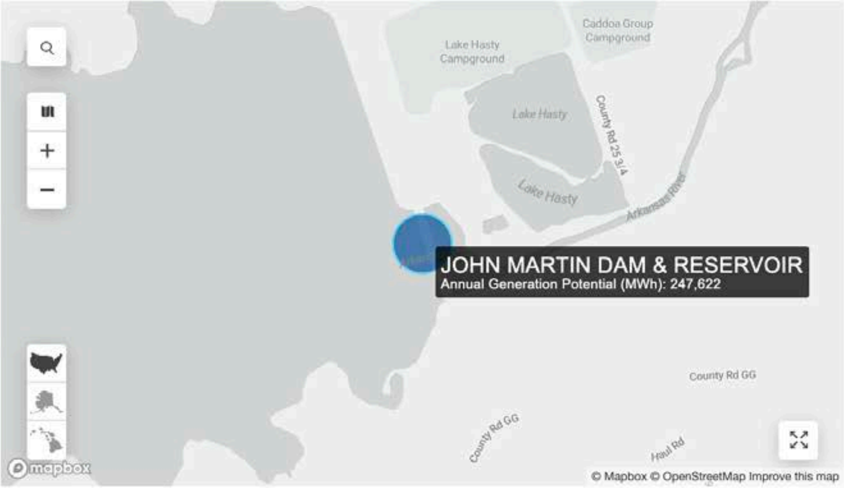
Data Filters

- Multi-Family, Renter Occupied
- Multi-Family, Owner Occupied
- Single Family, Renter Occupied
- Single Family, Owner Occupied

Does My Jurisdiction Have Hydropower Generation Potential?

Bent County

Hydropower - Non-Powered Dams



Current Map & Graph Resolution: Point Location

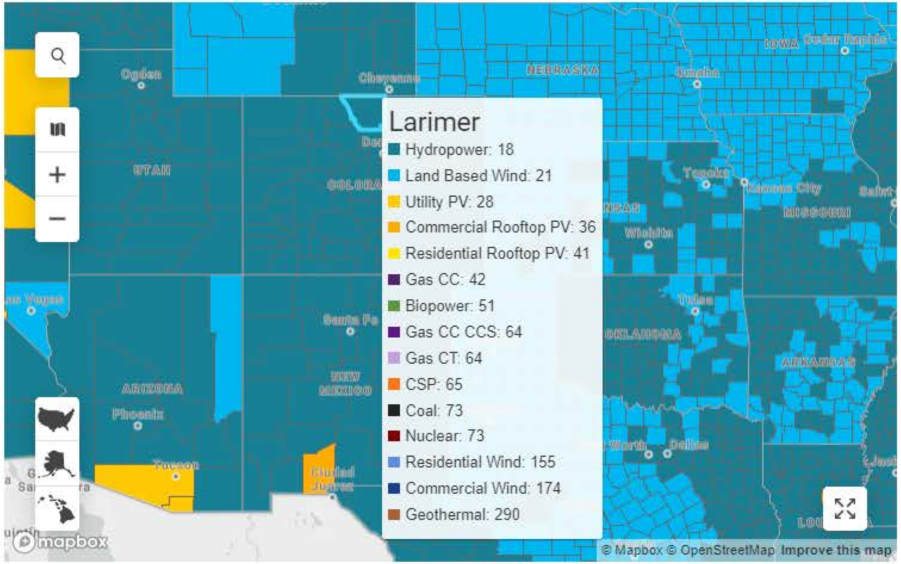
Hydropower - Non-Powered Dams

Month	Generation Potential - MWh	Capacity - MW
Annual	247622	79
January	10192	
February	9162	
March	12060	
April	16896	
May	43705	
June	52064	
July	32779	
August	27364	
September	12141	
October	11353	
November	10349	
December	9557	

NOTE: Non-powered dams are those that do not produce electricity but provide services ranging from water supply to inland navigation and other water conveyance infrastructures such as irrigation canals. Estimates factor technical characteristics described in the U.S. Department of Energy/Oak Ridge National Laboratory [Assessment of Energy Potential at Non-Powered Dams in the United States report].

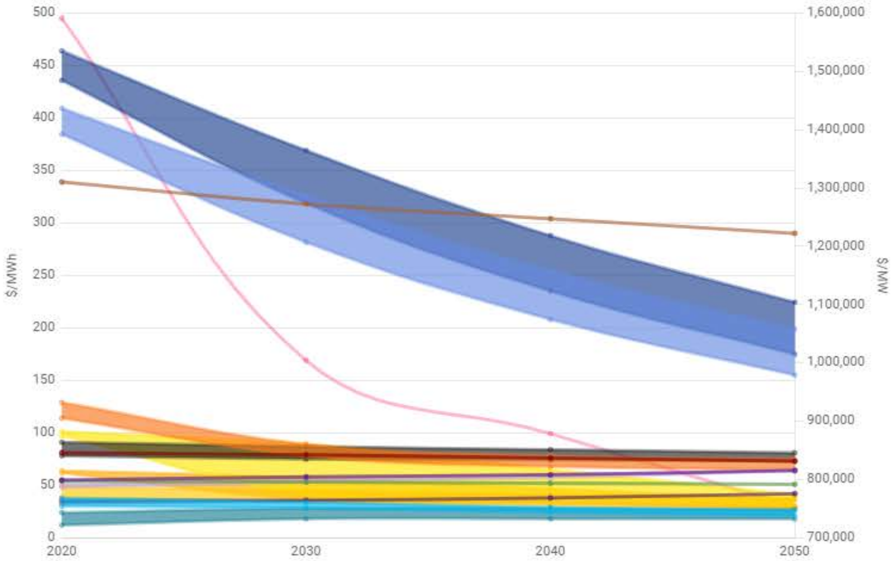
What Are the Lowest-Cost Electricity Generation Technologies in Our Area, Now and in the Future?

Generation Technology with Lowest Modeled Levelized Cost of Energy ($/MWh)



Map & Graph Resolution: County **State:** Colorado **County:** Larimer

Projected Levelized Cost of Energy by Technology - Larimer



Select Year

Takeaway: Hydropower from new stream reach and non-powered dam development could generate the lowest-levelized-cost electricity now and through 2050 in Larimer County, followed by utility wind and photovoltaics.

Thank you! Questions?

https://maps.nrel.gov/slope/

NREL/PR-6A20-87612

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