NREL
NATIONAL RENEWABLE ENERGY LABORATORY





National Renewable Energy Laboratory Data and Analysis on Energy in Cities

Megan Day, AICP

Colorado College Economics and Business Department Seminar Series

September 3, 2018

NREL/PR-7A40-72323

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy, Strategic Priorities and Impact Analysis. The views expressed in the presentation do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the presentation for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

Cities-LEAP

Cities Leading through Energy Analysis and Planning

DELIVERS standardized, localized energy data and analysis *that* **ENABLES** Cities to lead clean energy innovation *and* **INTEGRATE** strategic energy analysis into decision making

WHY CITIES?

Cities **consume** approximately

of **global energy**

Cities-LEAP

SUPPORTS THE WIDESPREAD IMPLEMENTATION

of city-sponsored, data-driven energy policies, programs, and projects that have the potential

to

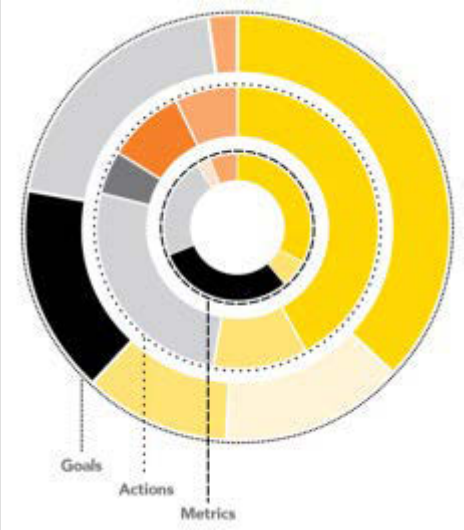
DRIVE A SEA CHANGE

in the national energy landscape.

Cities-LEAP – Cities Leading through Energy Analysis and Planning

FOUNDATIONAL RESEARCH

City-Level Energy Decision Making: Data Use in Energy Planning, Implementation, and Evaluation in U.S. Cities



CITY ENERGY PROFILES

Developed new, replicable methodology and generated a publicly available city energy profile for every U.S. city

CITY ENERGY FUTURES

Aggregate, national economic and GHG impact of suites of city energy actions

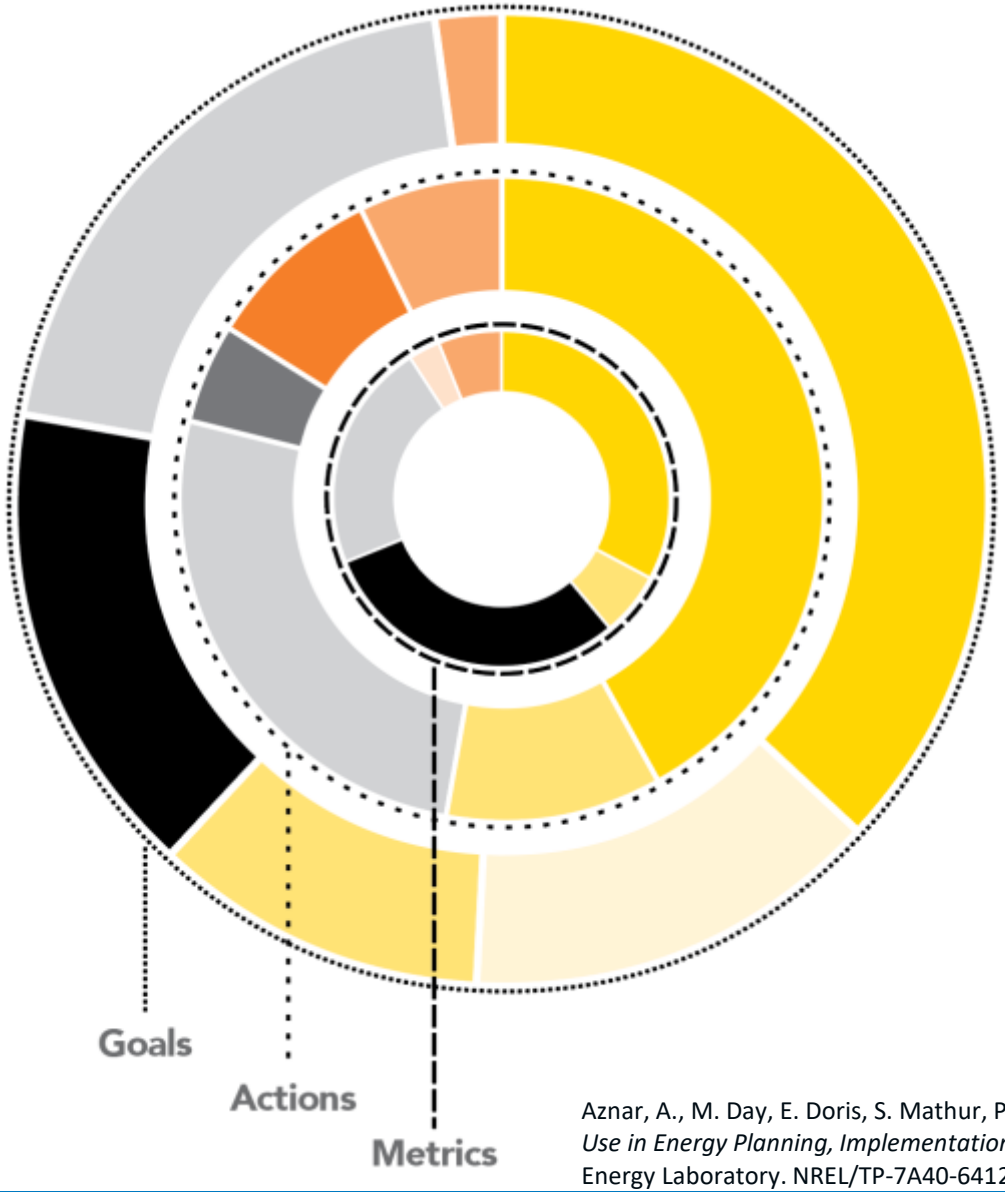
FUNDING OPPORTUNITY ANNOUNCEMENT

Three awardees pursuing innovative approaches to incorporating energy data in city decision making

DATA TO DECISIONS

Pathways to apply data

City-Level Energy Decision Making: Data Use in Energy Planning, Implementation, and Evaluation in U.S. Cities



- Transportation and Land Use
- Sustainability
- Renewable Power
- Energy and Emissions
- Buildings and Efficiency
- Electricity Supply and Infrastructure
- Municipal Operations and Programs
- Economic Development
- Other

The most common actions fall in the Transportation & Land Use and Buildings & Efficiency sectors.

Aznar, A., M. Day, E. Doris, S. Mathur, P. Donohoo-Vallett. 2015. *City-Level Energy Decision Making: Data Use in Energy Planning, Implementation, and Evaluation in U.S. Cities*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-64128. http://www.nrel.gov/docs/fy15osti/64128.pdf.

Factors that Impact City Energy Decision Making

- A city's level of influence in each sector
- Political priorities
- Timing and opportunities
- Staff capacity
- Data availability and granularity, data management and monitoring systems
- Cost considerations

Aznar, A., M. Day, E. Doris, S. Mathur, P. Donohoo-Vallett. 2015. *City-Level Energy Decision Making: Data Use in Energy Planning, Implementation, and Evaluation in U.S. Cities*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-64128. http://www.nrel.gov/docs/fy15osti/64128.pdf.

Cities-LEAP Energy Data for Every U.S. City:

Developed new, replicable methodology, estimated:

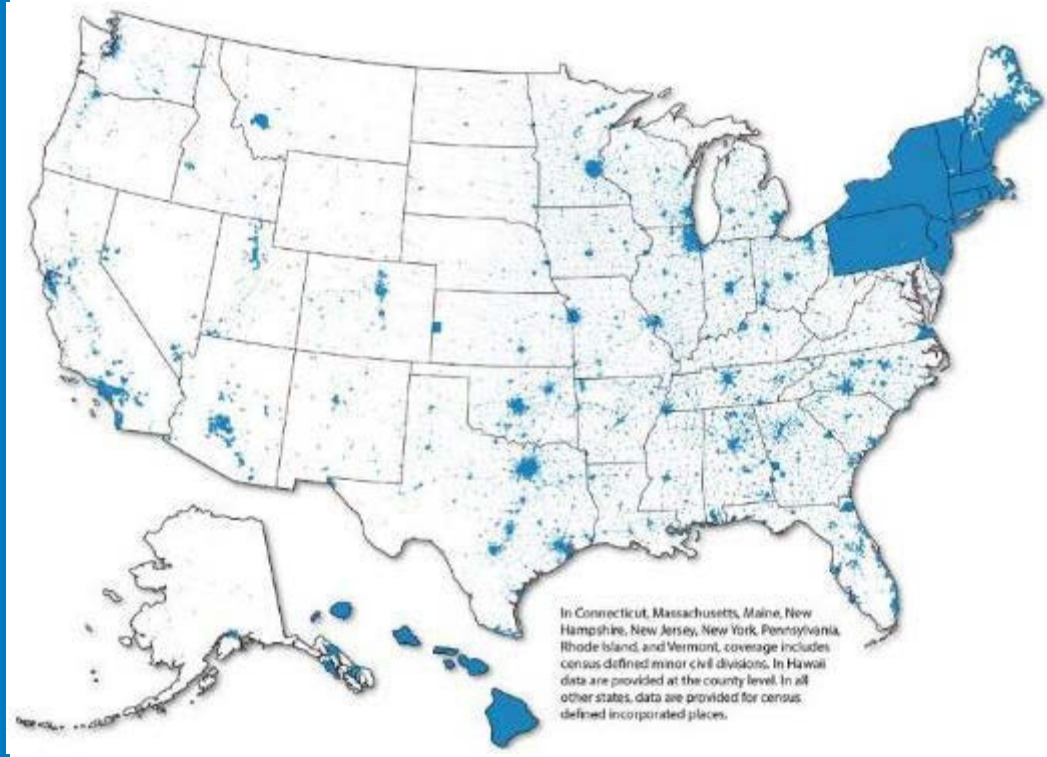
- Electricity, natural gas, vehicle fuel consumption, expenditures
- Vehicle miles traveled
- Rooftop PV potential
- Building stock by area, number, use
- Commercial and industrial energy consumption by NAICS code
- Building energy disclosure potential impact
- Housing types by income
- GHG emissions

Actual data on:

Registered vehicles

- Vehicle fuel types
- Average fuel economy

23,400+ U.S. Cities



https://apps1.eere.energy.gov/sled/

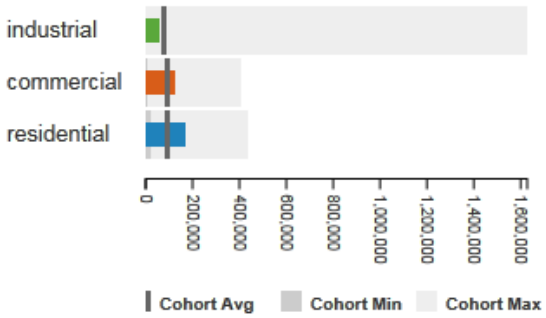
City Energy Profiles: Electricity, Natural Gas

Learning about the energy market in your city and similar cities can lead to more strategic energy decisions toward a clean energy future.

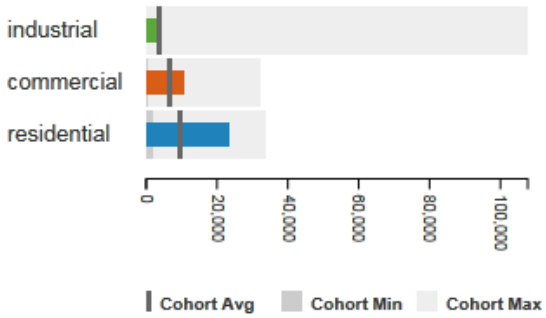
https://apps1.eere.energy.gov/sled

Electricity Statistics for Salem, Massachusetts in 2013 derived

ELECTRICITY USAGE
(MWH)

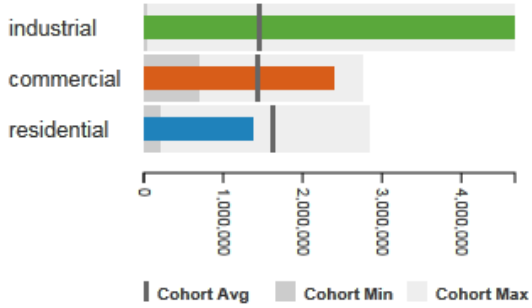


ELECTRICITY EXPENDITURES
($1000)

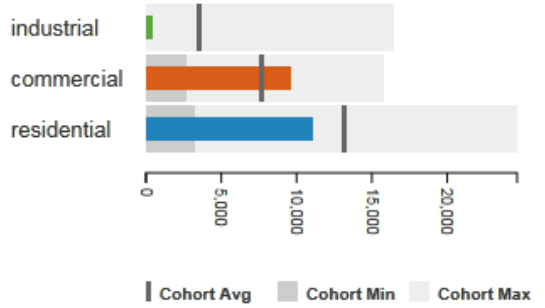


Natural Gas Statistics for Cheyenne, Wyoming in 2013 derived

NATURAL GAS USAGE
(MCF)



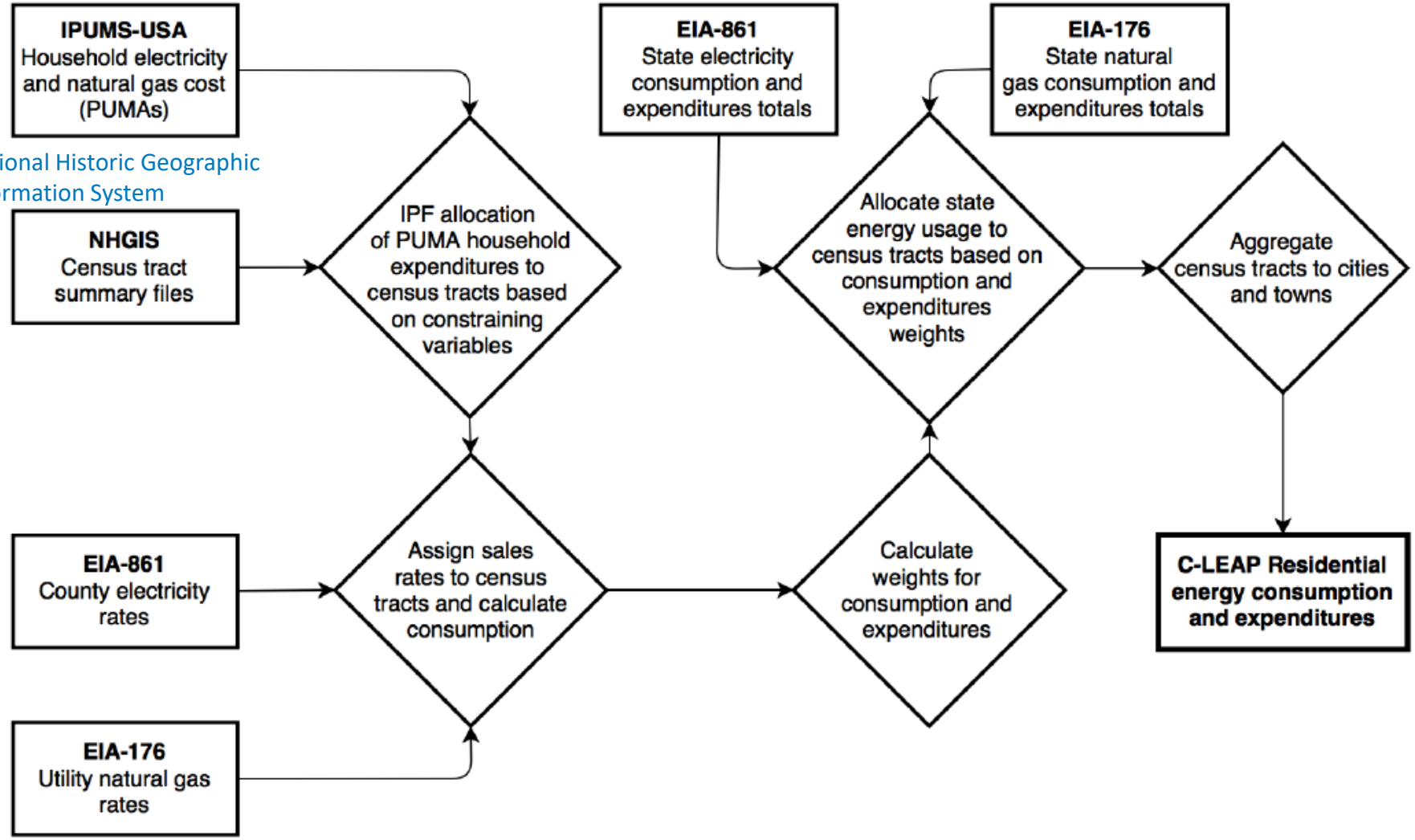
NATURAL GAS EXPENDITURES
($1000)



Electricity and Natural Gas Consumption and Expenditures Methodology

Integrated Public Use Microdata Series (IPUMS-USA)

National Historic Geographic Information System



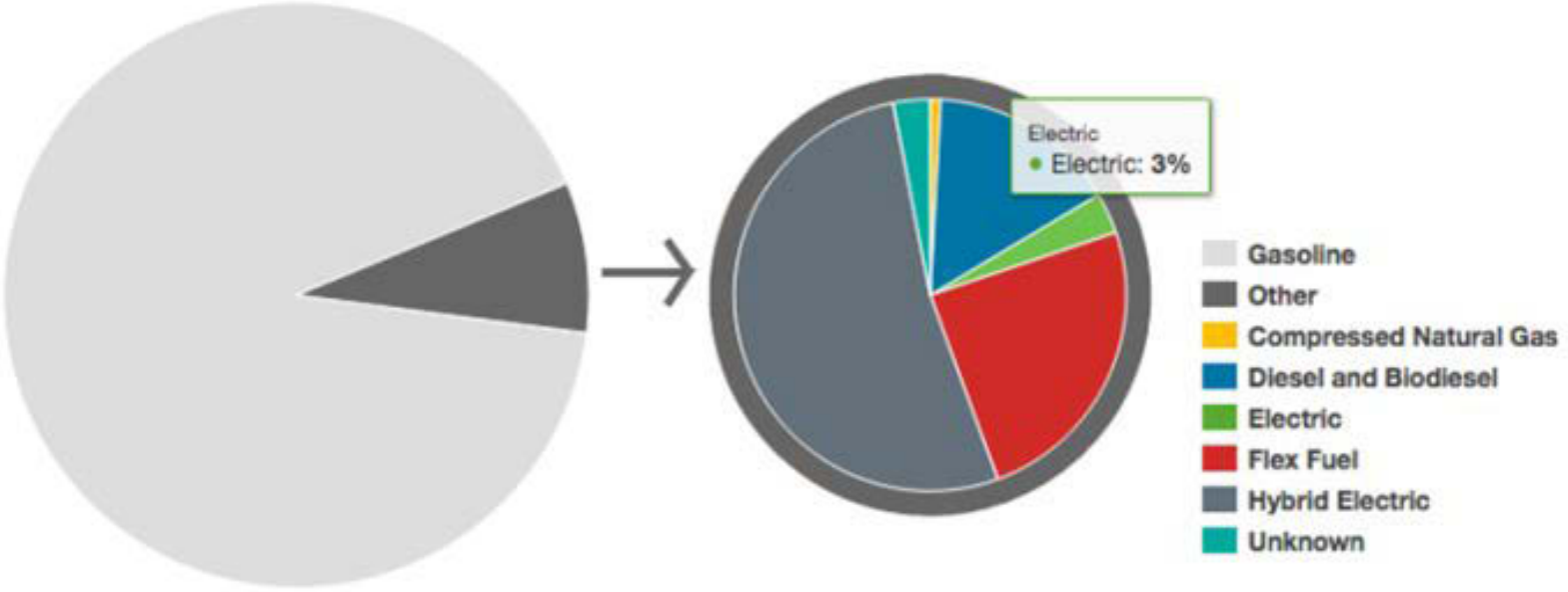
https://apps1.eere.energy.gov/sled

City Energy Profiles: Transportation – Fuel Types

Light-Duty Alternative Fuel and Conventional Vehicle, Oakland, CA

Total number of light-duty vehicles: 252,500

Average fuel economy of light-duty vehicles: 25.5 MPG



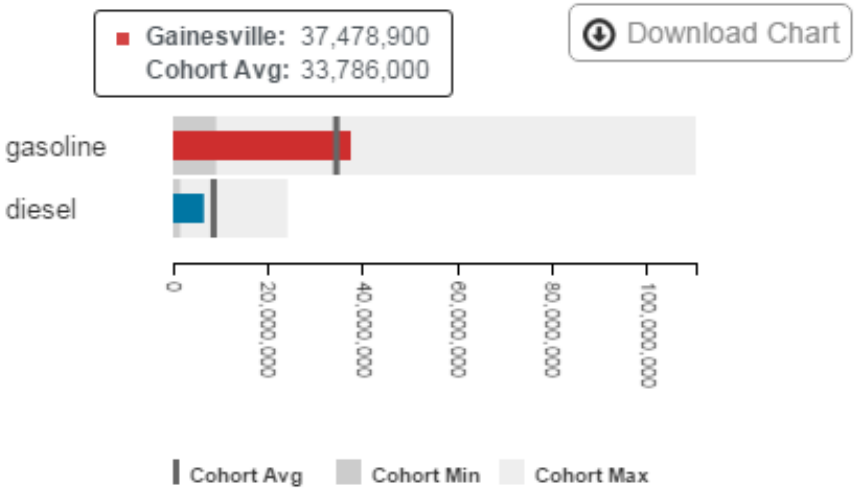
https://apps1.eere.energy.gov/sled

City Energy Profiles: Transportation – Fuel Use, VMT

Vehicle Data for Gainesville, Florida in 2013 derived

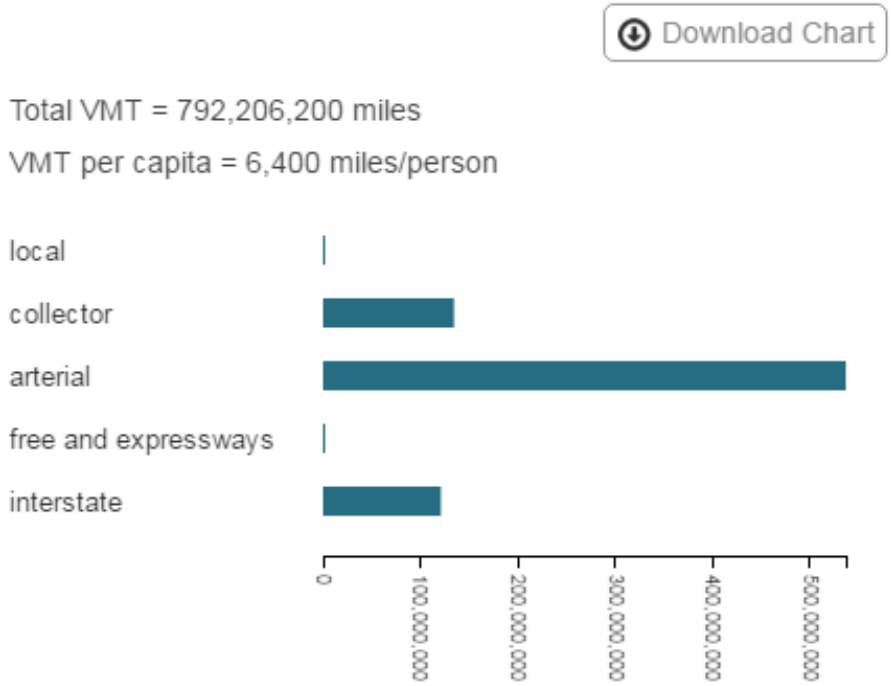
ON-ROAD VEHICLE FUEL USE (LIGHT, MEDIUM, AND HEAVY DUTY)

(GALLONS)



VEHICLE MILES TRAVELED BY ROAD CLASS

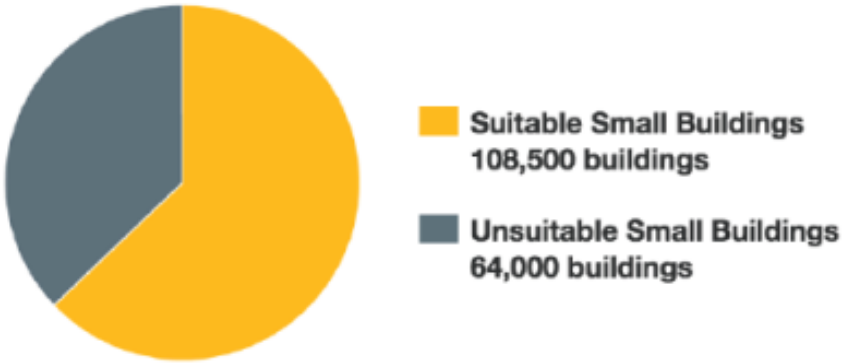
(TOTAL VMT)



https://apps1.eere.energy.gov/sled

City Energy Profiles: Buildings & Industry – Rooftop PV

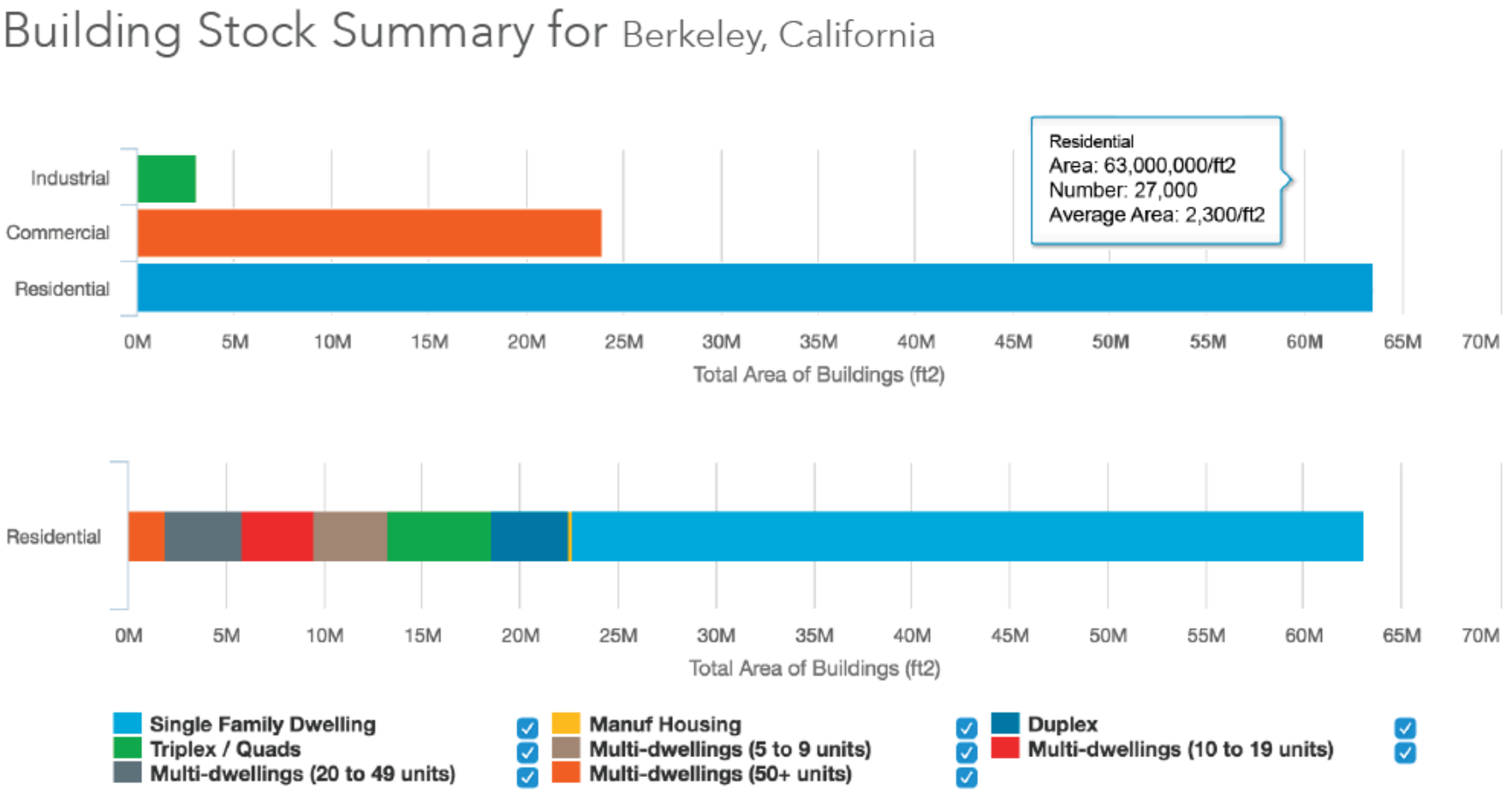
Small Building Rooftop PV Potential, Denver CO



Suitable area	5,000,000 m2
Capacity potential	700,000 kW
Energy generation potential	1,000,000 MWh

https://apps1.eere.energy.gov/sled

City Energy Profiles: Building Stock Characterization



http://apps1.eere.energy.gov/sled/#/.

City Energy Profiles: Commercial & Industrial Activity

Commercial Activities for Port St. Lucie, Florida derived

Commercial Activities - Top 5 Electricity Users	Number of Establishments	Electricity Use (MWh)	Rank	Electricity Use per Establishment	Rank
Hospitals	2	14,263	1	7,131	1
Nonstore Retailers	30	13,153	2	438	4
General Merchandise Stores	13	11,611	3	893	2
Administrative and Support Services	256	6,650	4	25	22
Food and Beverage Stores	41	4,968	5	121	10

Commercial Activities - Top 5 Natural Gas Users	Number of Establishments	Natural Gas Use (Mcf)	Rank	Natural Gas Use per Establishment	Rank
Hospitals	2	57,073	1	28,536	1
Nonstore Retailers	30	17,019	2	567	3
Nursing and Residential Care Facilities	30	13,702	3	456	4
Ambulatory Health Care Services	279	8,549	4	30	25
Educational Services	28	6,651	5	237	7

◉ **total usage**

○ **per establishment**

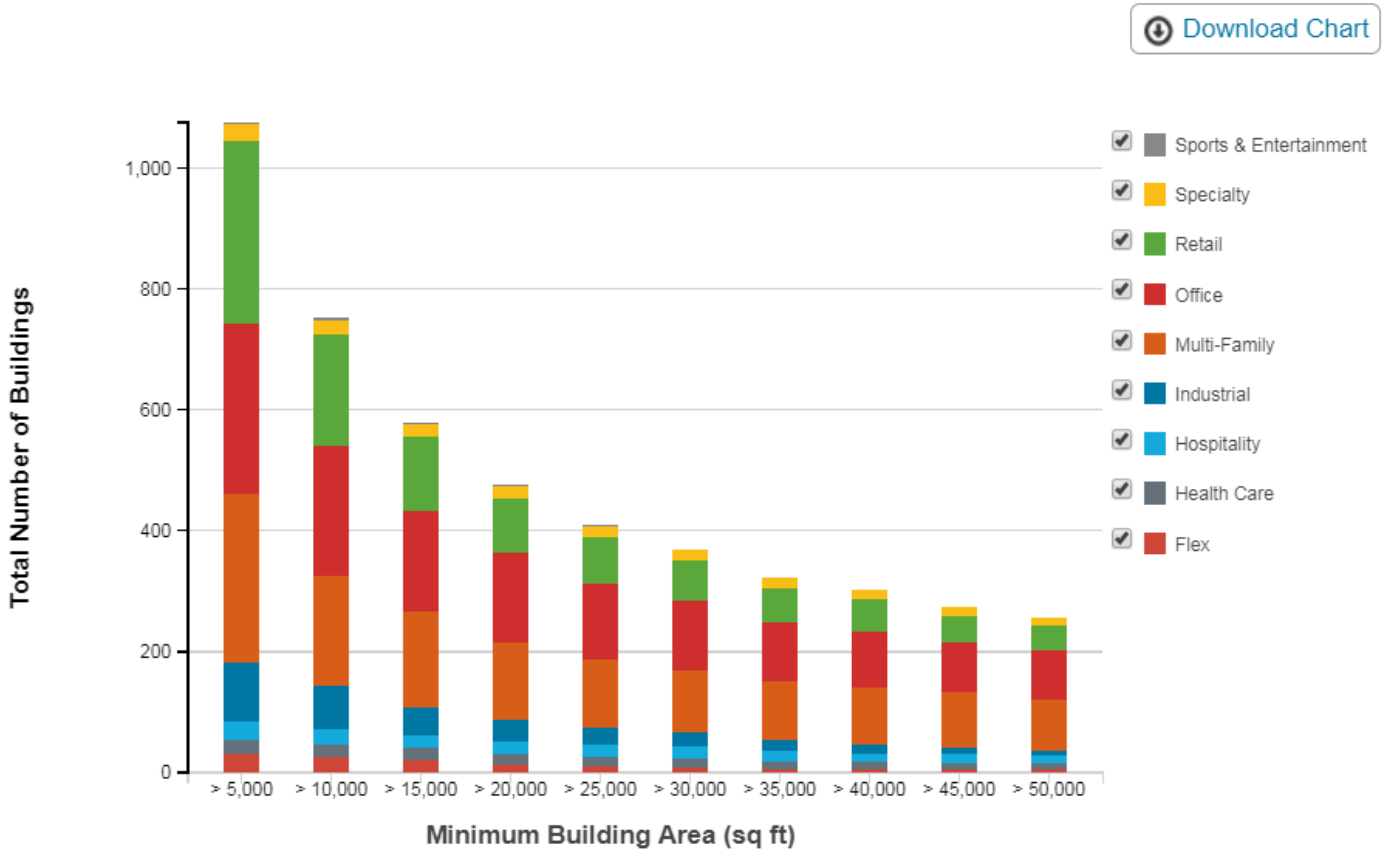
https://apps1.eere.energy.gov/sled

City Energy Profiles: Commercial Building Energy Benchmarking

Commercial Building Energy Benchmarking for Lakewood, Colorado

derived

The following chart shows commercial properties from CoStar Realty Information, Inc. (www.costar.com) by building area and property type. Cities can use this data to estimate the potential scope and impact of building energy benchmarking policies or programs.



https://apps1.eere.energy.gov/sled

City Energy Profiles: Greenhouse Gas Emissions Summary

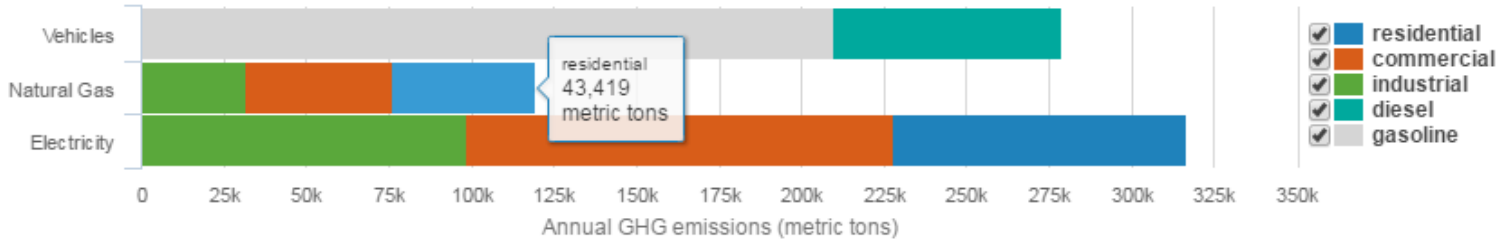
Annual Energy GHG Emissions for Redmond, Washington derived

Total GHG: 715,000 metric tons

GHG per capita: 13 metric tons/person

GHG per BTU: 0.08 metric tons/MMBTU

Download Chart



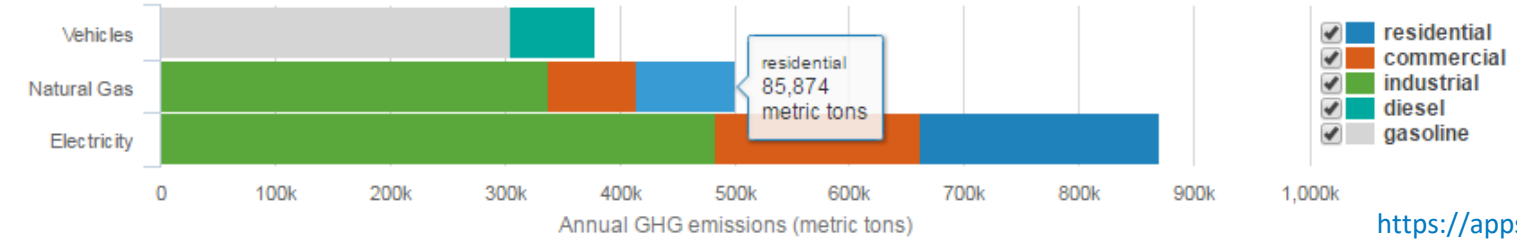
Annual Energy GHG Emissions for Canton, Ohio derived

Total GHG: 1,750,200 metric tons

GHG per capita: 23 metric tons/person

GHG per BTU: 0.10 metric tons/MMBTU

Download Chart

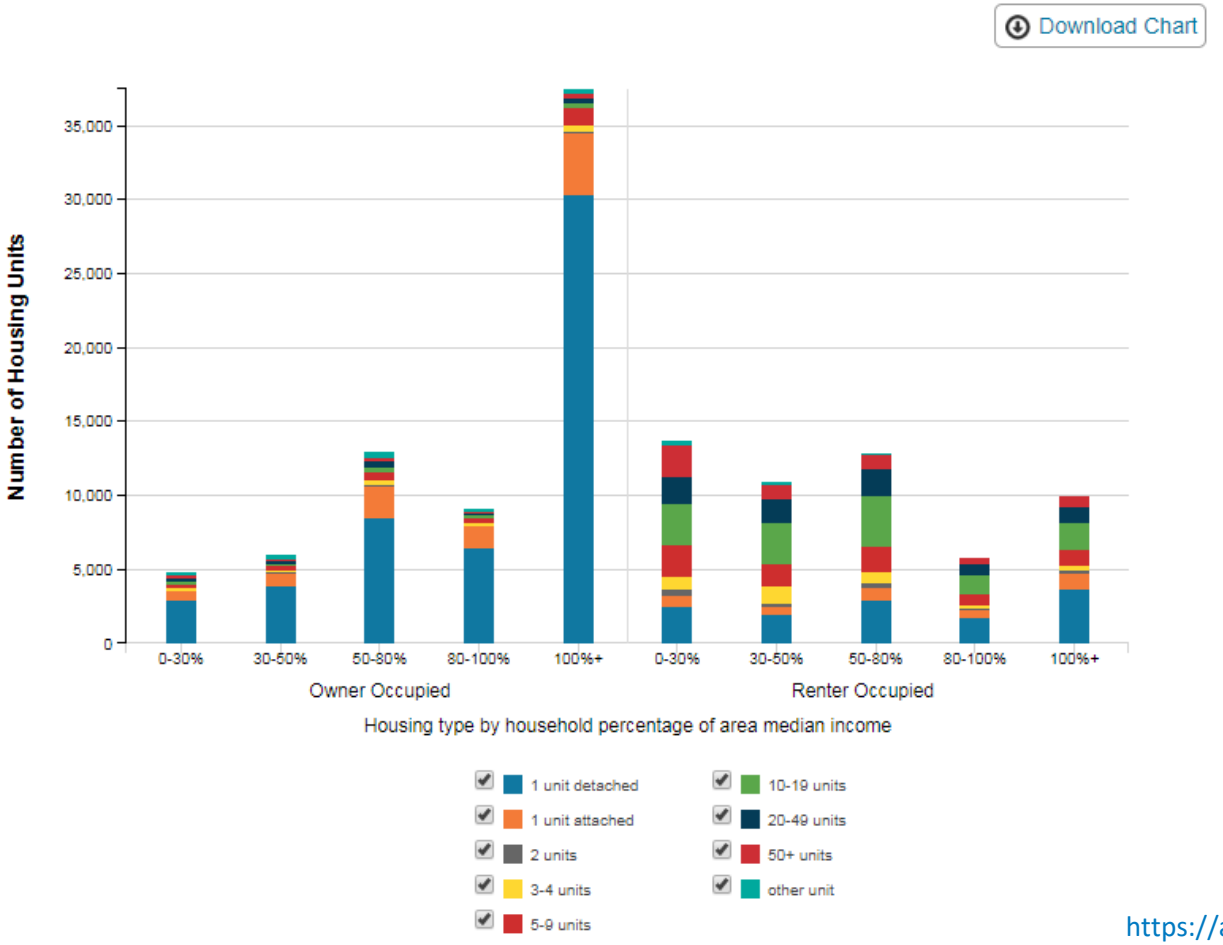


https://apps1.eere.energy.gov/sled

City Energy Profiles: Income and Housing Data

Estimated Housing Units by Type and Area Median Income for Aurora, Colorado in 2015

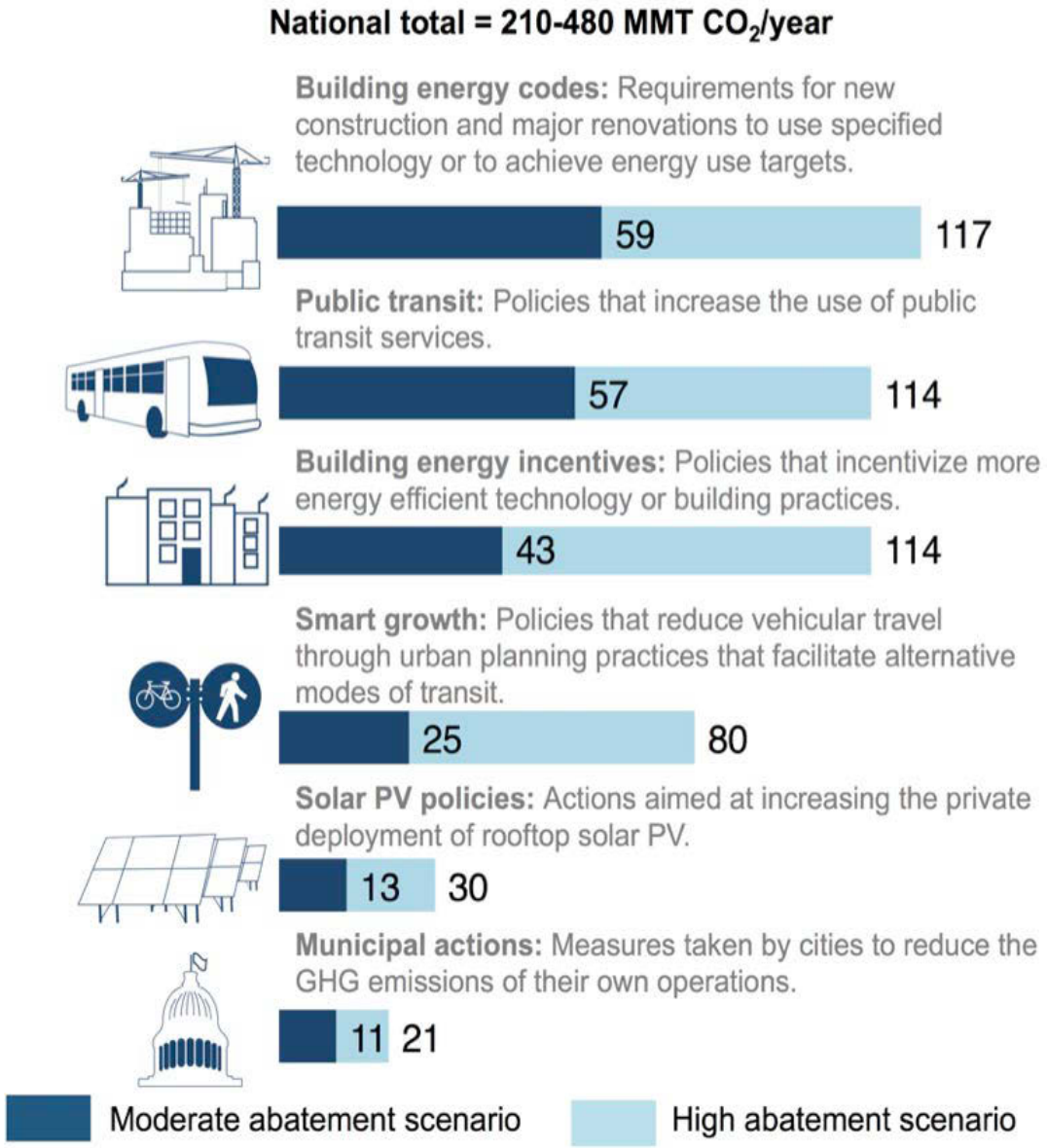
The following chart provides estimated housing types by area median income (AMI) and tenure (renter- or owner-occupied). The U.S. Department of Housing and Urban Development (HUD) defines "very-low income" as households earning 50% or less of AMI for a given location. Income and housing data can help cities understand their low- and moderate-income community characteristics and design programs, policies, and goals to benefit lower income residents. Additional data and analysis may be found on the Low-Income Energy Affordability Data (LEAD) Tool on OpenEI.



https://apps1.eere.energy.gov/sled

Estimating the National Carbon Abatement Potential of City Policies: A Data-Driven Approach

Commonly implemented city actions have the potential to achieve 35% of the remaining US COP21 target.



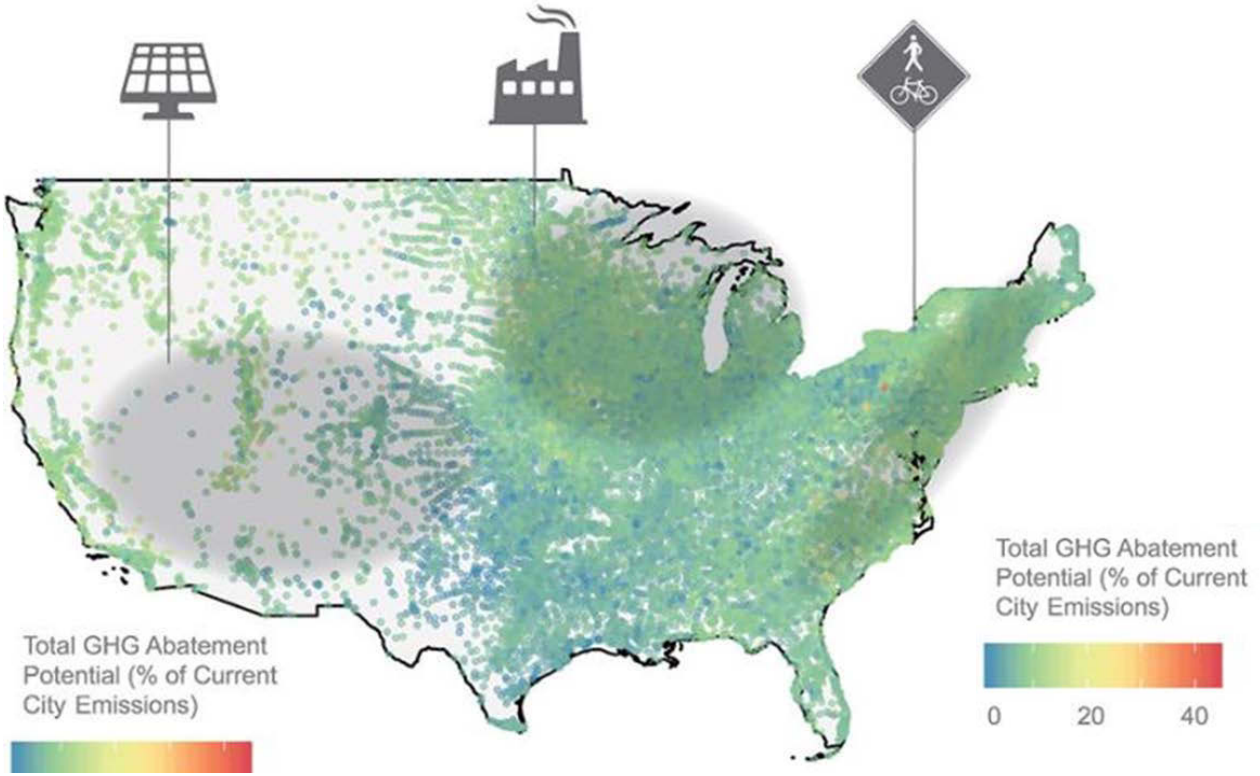
O'Shaughnessy, E., et al. (2016). *Estimating the National Carbon Abatement Potential of City Policies: A Data-Driven Approach*. NREL: http://www.nrel.gov/docs/fy17osti/67101.pdf.

Estimating the National Carbon Abatement Potential of City Policies: A Data-Driven Approach

The excellent solar resource in southwestern cities provides an opportunity to use distributed solar PV policies for CO_2 abatement. The CO_2 abatement potential of solar PV policies in Arizona and California was about 20% greater than other cities.[v]

Building energy policies may be more impactful in midwestern and northern cities where buildings use more natural gas for heating during colder winters. The estimated CO_2 abatement potential of building energy requirements is about 50% higher in midwestern cities than other cities.[v]

Transportation-related policies may be more effective in eastern coastal cities where large urban areas result in higher vehicle miles of travel. The estimated CO_2 abatement potential of smart growth policies was about twice as high in eastern coastal cities than other cities.[v]



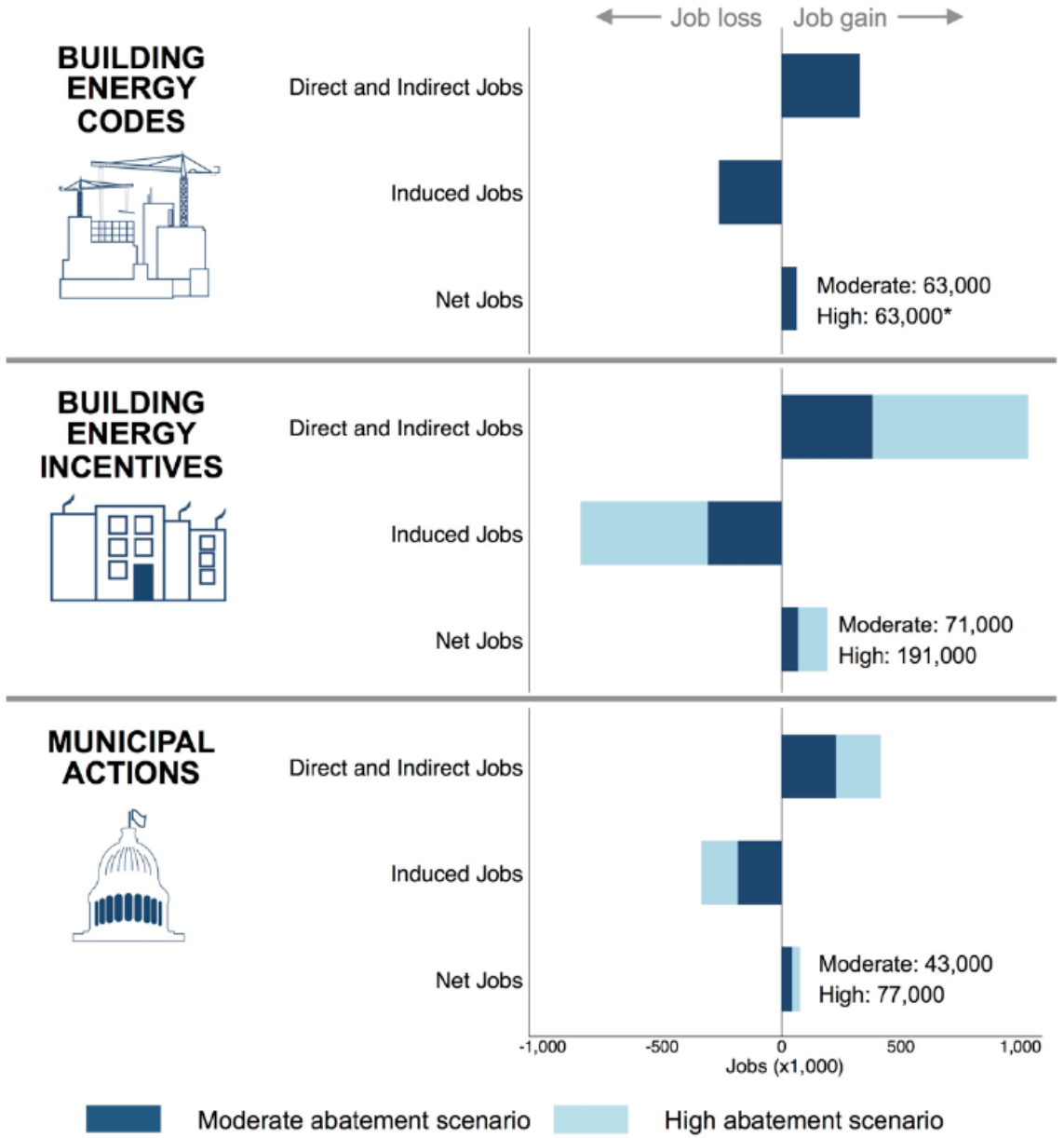
https://www.energy.gov/eere/analysis/downloads/estimating-national-carbon-abatement-potential-city-policies-data-driven

Estimating the National Carbon Abatement Potential of City Policies: A Data-Driven Approach

Estimated national employment impacts during implementation of actions in three policy areas

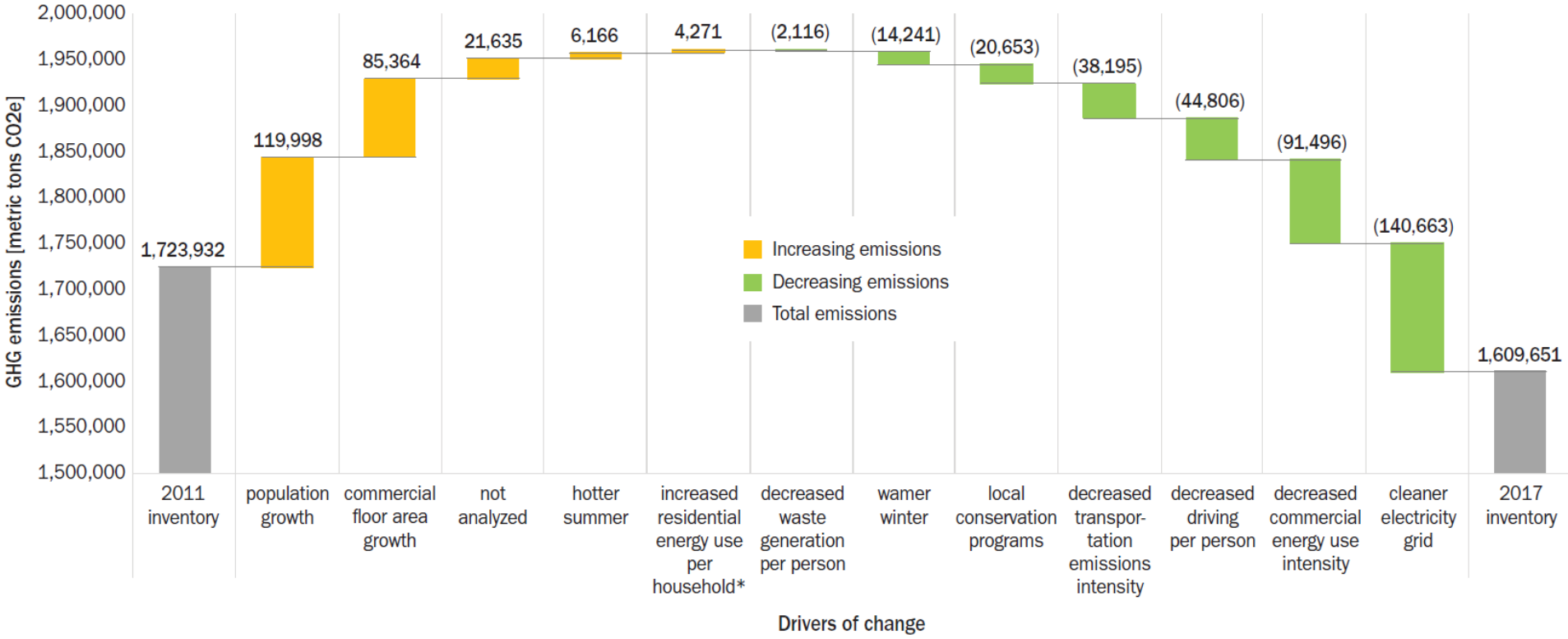
Using an IMPLAN input–output (I-O) model to estimate direct, indirect, and induced impacts, we find city actions across three of the policy areas considered could support between 52,000 net jobs nationally (moderate abatement scenario) and 269,000 net jobs (high abatement scenario) while being implemented and an average of 6,000 jobs (moderate) to 96,000 jobs (high) annually thereafter.

Analysis suggests the net economic impacts of city carbon abatement actions are minimal and generally slightly positive.



O'Shaughnessy, E., et al. (2016). *Estimating the National Carbon Abatement Potential of City Policies: A Data-Driven Approach*. NREL: http://www.nrel.gov/docs/fy17osti/67101.pdf.

City Emissions – Drivers of Change Analysis



Drivers of change in emissions in the City of Bellevue, Washington

*After accounting for weather. This change is the net effect of factors that may include occupant behavior, changes to building types and uses, federal appliance standards, utility programs and new electronic devices.

Drivers of Change Analysis for Local GHG Emissions: Data for Better Decisions. U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. 2018. https://www.energy.gov/eere/analysis/drivers-change-local-greenhouse-gas-emissions-toolkit

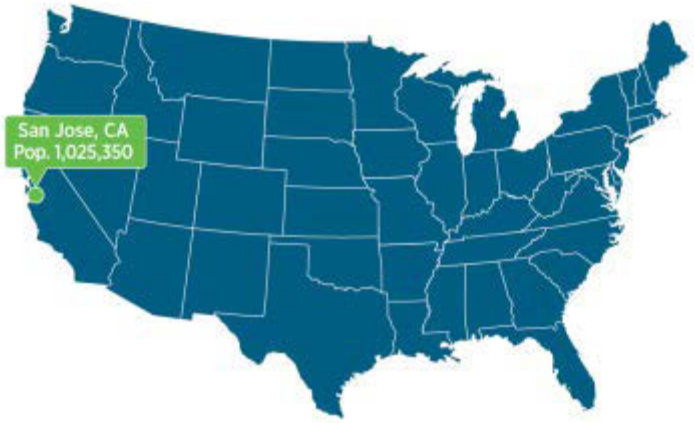
City Energy – From Data to Decisions

Cities-LEAP Partnered with ten cities to demonstrate pathways to apply Cities-LEAP and SLED data and analysis to inform energy planning and decision making

- **Asheville, NC** Building energy efficiency
- **Boise, ID** Reducing vehicle fuel consumption
- **Carrboro, NC** Targeting efficiency for low income households
- **Columbia, MO** GHG reduction, efficiency for low income households
- **Denton, TX** Reducing vehicle miles traveled and fuel consumption
- **Lafayette, CO** Planning for EV infrastructure
- **Moab, UT** Building energy efficiency
- **New Haven, CT** Targeting efficiency for low income households
- **San Jose, CA** Rooftop PV market potential
- **South Lake Tahoe, CA** EE for buildings and local industries

https://energy.gov/eere/analysis/downloads/city-energy-data-decisions

City Energy: From Data to Decisions



"The Cities-LEAP analysis will help the City of San Jose make critical decisions in developing renewable energy programs, moving toward its renewable energy and energy efficiency goals, and ultimately allowing San Jose to reach its greenhouse gas reduction targets."

– Ken Davies, Sustainability and Compliance Manager, City of San Jose

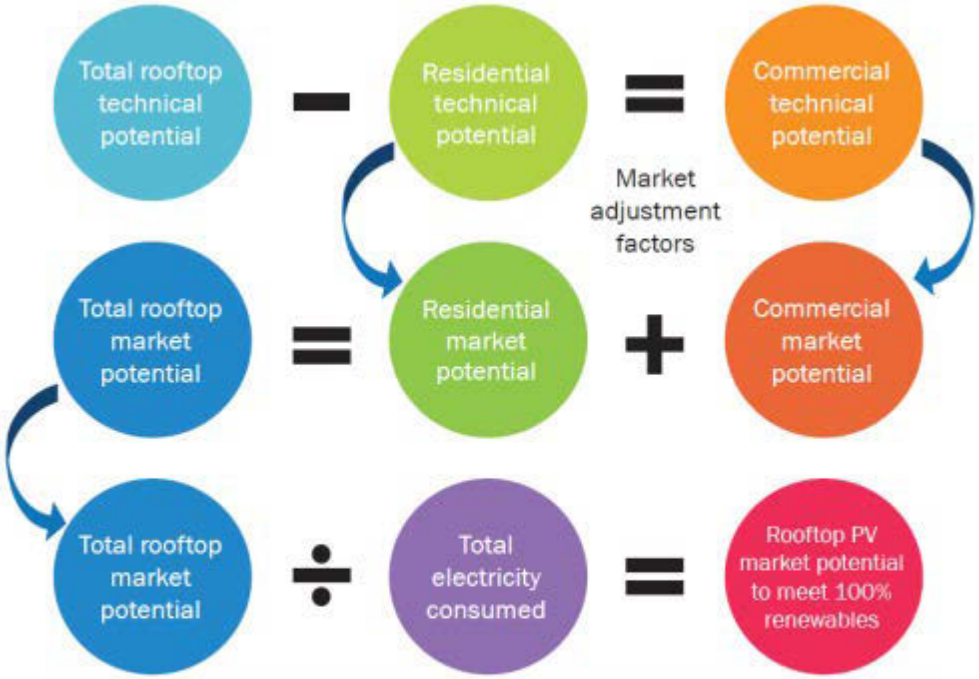
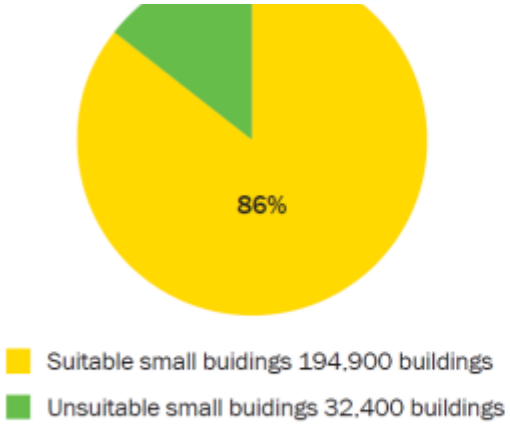


Figure 1. Conceptual framework for estimating rooftop PV market potential to meet 100% renewable goals (Source: NREL)



Suitable area	11,518,500 m^2
Capacity potential	1,638,500 kW
Energy generation potential	2,420,600 MWh

Figure 3. Small building/residential rooftop PV technical potential in San Jose, California (Source: SLED)

https://energy.gov/eere/analysis/downloads/city-energy-data-decisions

City Energy – From Data to Decisions

Low-Income Energy Affordability Analysis

Identifying geographic concentrations of households with a high energy burden can inform more strategic policy decisions and targeted energy efficiency interventions.

https://www.energy.gov/eere/analysis/downloads/city-energy-data-decisions

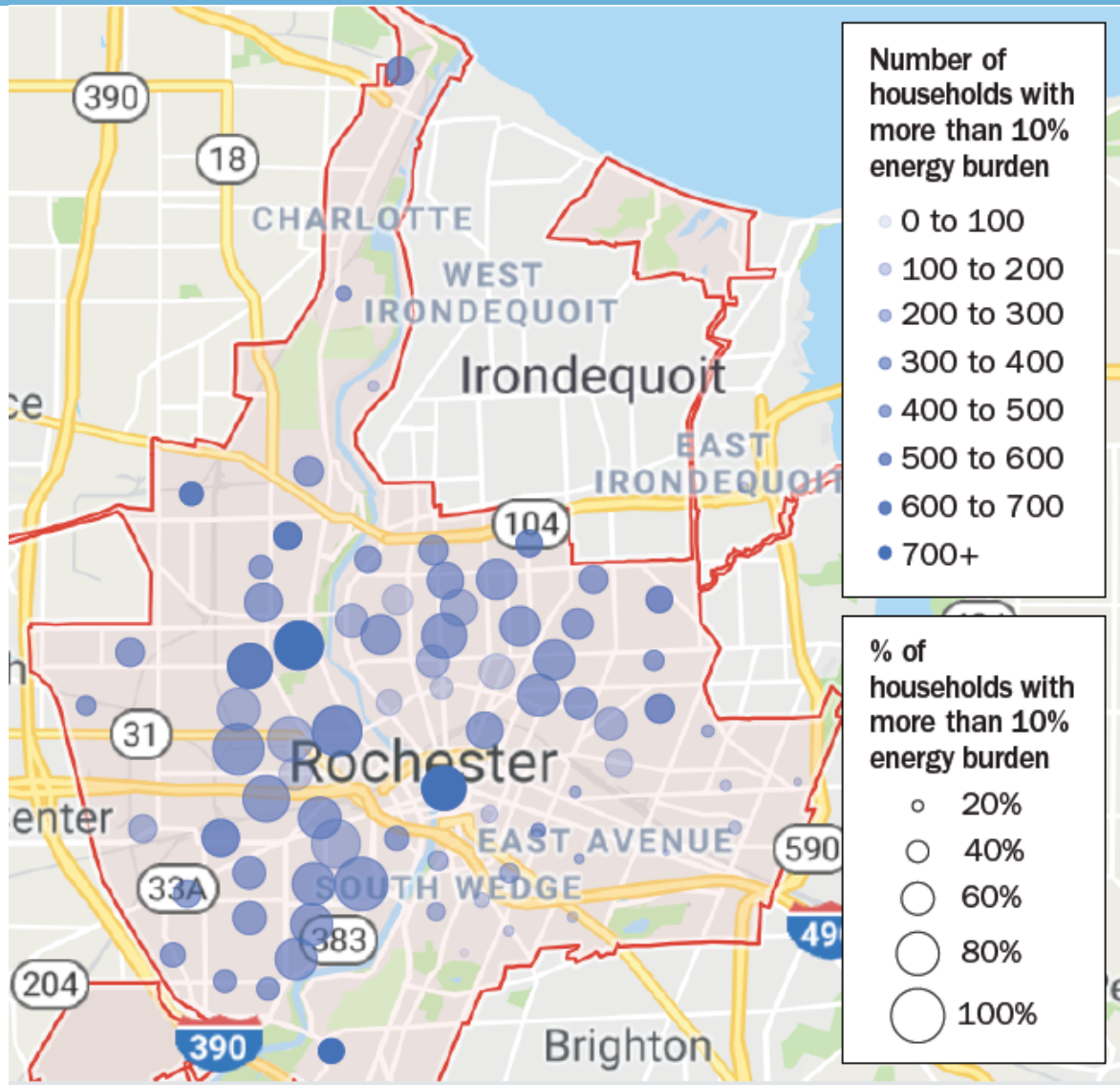
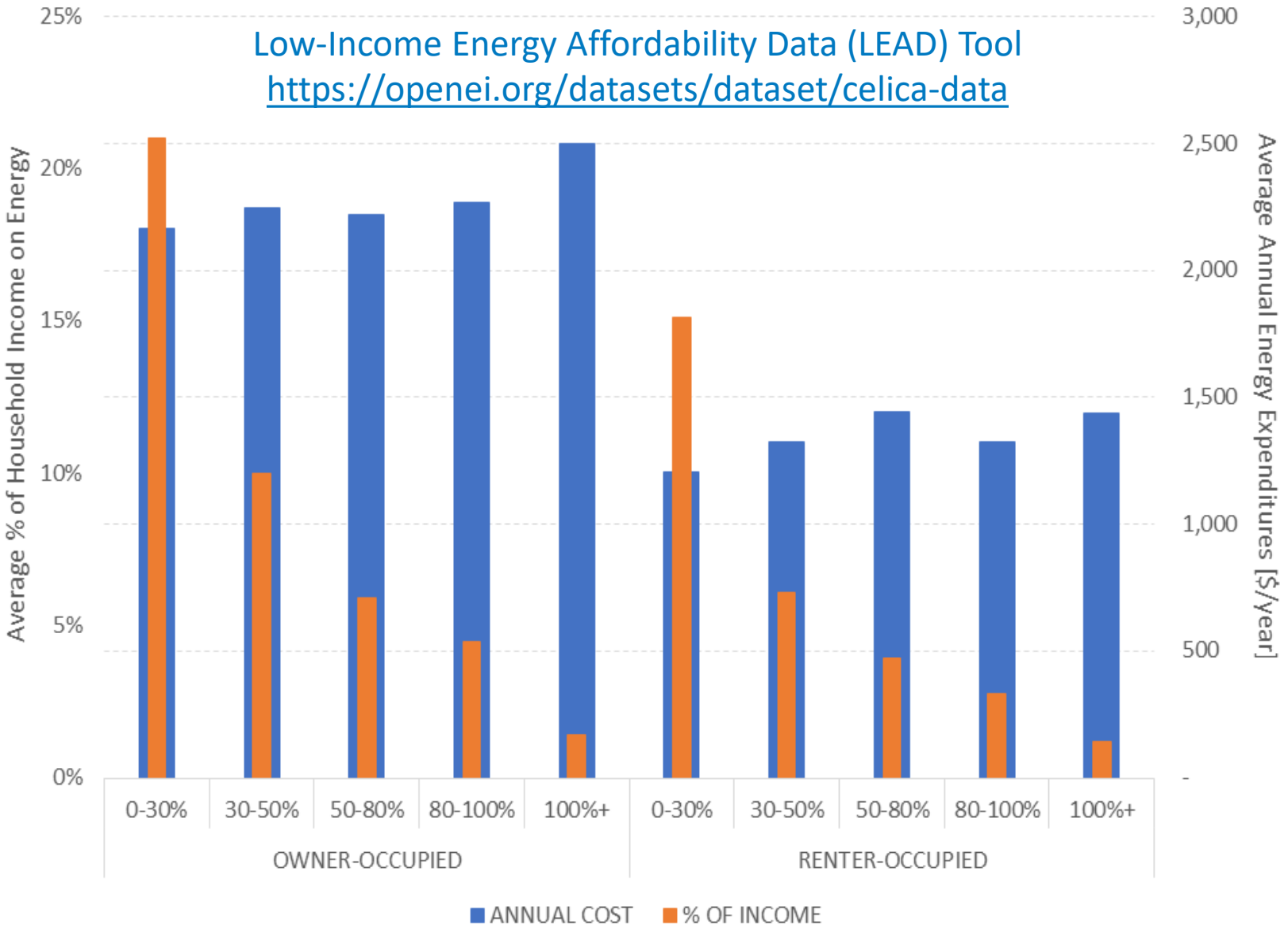


Figure 3. Estimated number of housing units with greater than 10% energy burden by U.S. Census tract in Rochester, New York. (Source: LEAD tool: https://openei.org/datasets/dataset/celica-data)

Low-Income Energy Affordability Data

Energy Burden Estimates, Carrboro, NC (2015)

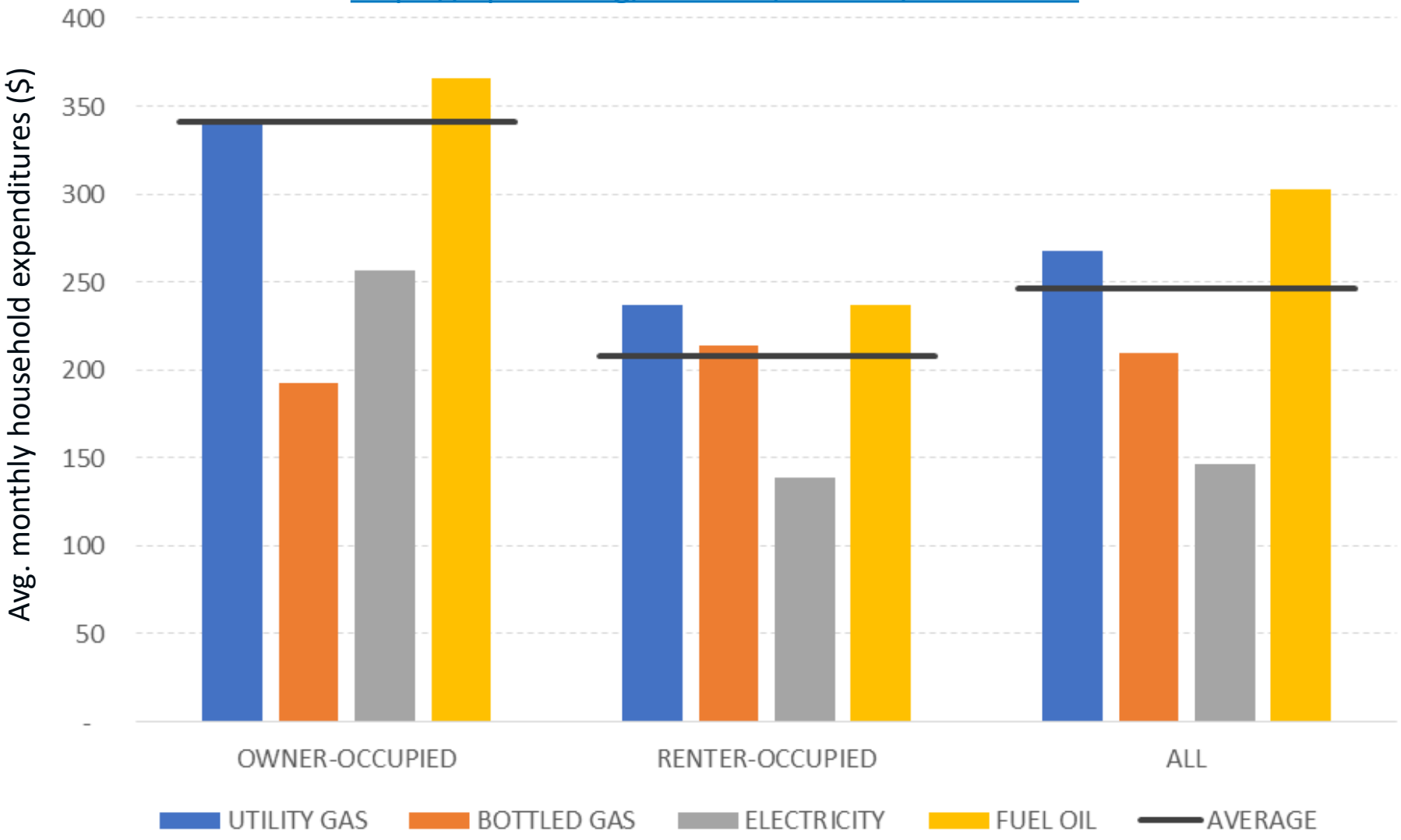
Low-Income Energy Affordability Data (LEAD) Tool
https://openei.org/datasets/dataset/celica-data



Low-Income Energy Affordability Data

Average monthly expenditures by heating fuel type in New Haven, CT (2015)

https://openei.org/datasets/dataset/celica-data



ACCESS CITY ENERGY PROFILES, TOOL BOX

apps1.eere.energy.gov/sled

ACCESS THE REPORTS

City Energy: From Data to Decisions

https://www.energy.gov/eere/analysis/downloads/city-energy-data-decisions

City-Level Energy Decision Making: *Data Use in Energy Planning, Implementation, and Evaluation in U.S. Cities*

http://www.nrel.gov/docs/fy15osti/64128.pdf

Estimating the National Carbon Abatement Potential of City Policies:

A Data Driven Approach

http://www.nrel.gov/docs/fy17osti/67101.pdf

STAY INFORMED

Learn more and sign up for email updates:

www.energy.gov/eere/cities

NREL state, local, and tribal programs on Twitter @NREL_Conduit

CONTACT

Megan.day@nrel.gov

www.nrel.gov

NREL
NATIONAL RENEWABLE ENERGY LABORATORY