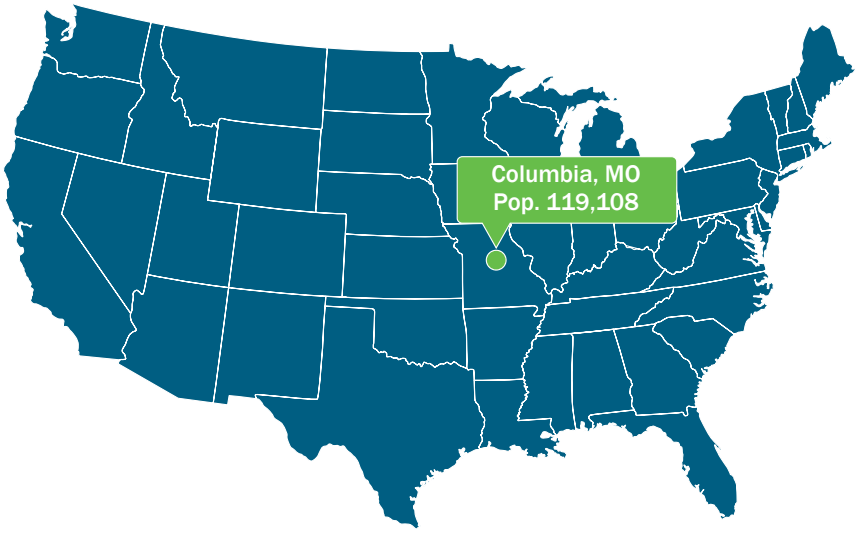
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

CITY ENERGY: FROM DATA TO DECISIONS

Columbia, Missouri: Using Energy Data to Reduce Emissions and Achieve Low-Income Household Energy Savings



The City of Columbia partnered with the Energy Department and the National Renewable Energy Laboratory (NREL) to demonstrate how data and analysis can inform more strategic energy decisions. NREL based its analysis in-part on the City Energy Profiles on the State and Local Energy Data (SLED) website (*eere.energy.gov/sled*). The profiles contain data compiled by SLED and the Cities Leading through Energy Analysis and Planning (Cities-LEAP) program. Cities across the country can follow the same approach and use data-driven analysis in their own energy planning.

> "The Cities-LEAP and SLED data helped Columbia focus efforts to achieve our strategic plan's goal of reducing our carbon footprint. The data collected and analyzed helps staff focus on the actions that will have the greatest impact on this goal while benefiting low-income residents. It also gave us some great examples of best practices other cities are using to address the same community concerns."
>
> *— Barbara Buffaloe, Sustainability Manager, City of Columbia*

City Energy Questions

The City of Columbia, Missouri, wanted to inform its energy goal setting with a better understanding of the following:

1. What kinds of energy actions and policies would have the greatest impact in reducing the city's greenhouse gas (GHG) emissions?
2. Which energy actions and policies would have the greatest benefit for low- and moderate-income households, particularly renter-occupied households?

Smaller to mid-sized communities like Columbia often don't have the resources they need to determine the answers to these questions on their own.

Columbia is a college town with a large transient population and a relatively high percentage of renters. The city also has a higher-than-average percentage of the population living below the poverty level, as well as higher-than-average residential energy expenditures. As such, the city is prioritizing residential energy efficiency programs, particularly in the rental sector.

Data and Analysis

In conducting the analysis for Columbia, NREL evaluated data available on SLED, including demographic data on income and housing occupancy, per capita residential electricity usage and expenditures, residential building stock, building area by type of building, and current GHG emissions levels. Columbia provided measured data where available to replace the estimated data from SLED in the analysis. NREL then compared these Columbia-specific data points to both national averages and cities with similar populations and climate zones (cohort cities) to place the Columbia data into context.

The SLED data, along with the SLED toolbox of resources for city-level energy actions (*apps1.eere.energy.gov/sled/cleap.html*) informed the analysis, which provided a menu of options for Columbia.

Reducing GHG Emissions

To answer Columbia's first question, NREL adjusted the GHG emissions summary for Columbia provided on SLED to reflect measured electricity and natural gas consumption data provided by the city. The adjusted data shows electricity consumption drives the majority of the city's emissions (see Figure 1), based on the generation mix that serves the area. Of the end use sectors, the commercial sector energy use drives the highest GHG emissions, followed by on-road vehicle GHG emissions from gasoline and diesel fuel consumption.

Next, NREL created a snapshot of Columbia emissions reductions potential from various city-level actions (see Figure 2) using a recent abatement potential study, along with city-provided residential and commercial building electricity and natural gas consumption, as well as SLED estimates of annual vehicle miles traveled.[1] NREL estimated the reduction potential of possible city actions in the buildings, transportation, and municipal sectors over the next 15 years.

The analysis revealed that adopting the latest building code vintages, in combination with beyond-code energy efficiency standards (particularly for renovations), could have the greatest potential to reduce GHG emissions for Columbia, followed closely by actions to expand public transit services and increase ridership.

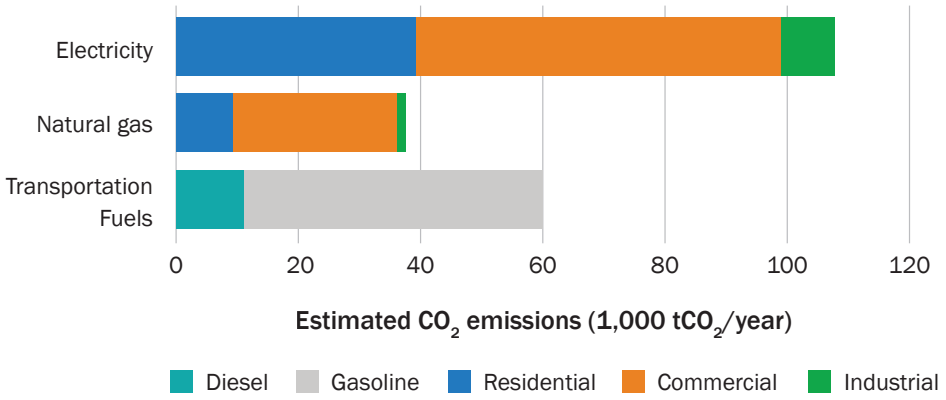


Figure 1. Annual energy GHG emissions (2013) for Columbia, Missouri
(Source: SLED and adjusted with data provided by the city of Columbia [2013])

Building Code Options

Strategies to achieve the GHG emissions reduction potential of nearly 60,000 metric tons of CO_2 (tCO_2) per year include adopting the latest building code vintages and establishing mechanisms to fully realize energy savings from existing building energy codes. City building code options include the following:

- Increase resources for compliance activities
- Conduct periodic compliance studies
- Provide education and training opportunities to building designers and contractors
- Use third-party compliance reviews for code enforcement
- Establish performance metrics that third-party reviewers must assess
- Adopt beyond-code measures (i.e., city policies that go beyond state-level or the latest vintage of building codes).

Transportation Efficiency Options

Strategies to reduce transportation sector emissions through public transit services include the following activities:

- Expand public transit service through new routes, increased frequency, or increased ridership
- Create special lanes for buses and high-occupancy vehicles and enable traffic signal preemption to give public transportation priority access through intersections
- Manage parking through pricing, building, and development incentives to reduce parking space requirements
- Initiate commute trip reduction programs (e.g., commuter financial incentives, rideshare matching, and guaranteed rides home).

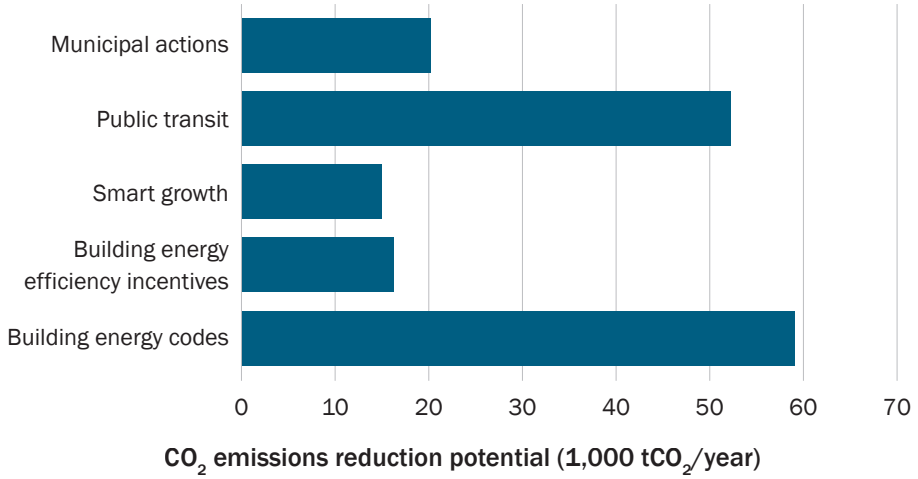


Figure 2. Annual GHG reduction potential of city actions for Columbia, Missouri
(Source: Based on an NREL carbon abatement potential study [*https://energy.gov/node/2104835*], city-provided data, and SLED data)

[1] O'Shaughnessy et al., *Estimating the National Carbon Abatement Potential of City Policies: A Data-Driven Approach,* National Renewable Energy Laboratory (2016), NREL-67101, https://energy.gov/node/2104835. City-provided data included efficiency program participation rates, new construction and major renovation rates, growth rate, share of new growth anticipated to be infill and transit-oriented, public transit service and ridership expansion, city fleet hybridization percentage, and the percent of municipal operations procured from renewable sources within the next 15 years.

Achieving Low-Income Household Energy Savings

To answer Columbia's second question, NREL analyzed residential electricity consumption and expenditures. SLED data shows that Columbia's household electricity consumption is an estimated 68% higher than the national average, and annual household electricity expenditures are an estimated $500 (45%) above the national average (see Figure 3). This data suggests significant opportunity for household energy efficiency improvements and cost savings, which can be realized by targeting rental households with electricity efficiency measures and increasing efficiency standards in building codes. Such measures would help low-income households reduce electricity and natural gas consumption and associated costs while reducing emissions from the estimated 488,000 tons of GHG emissions attributed to the residential sector in Columbia (see Figure 1).

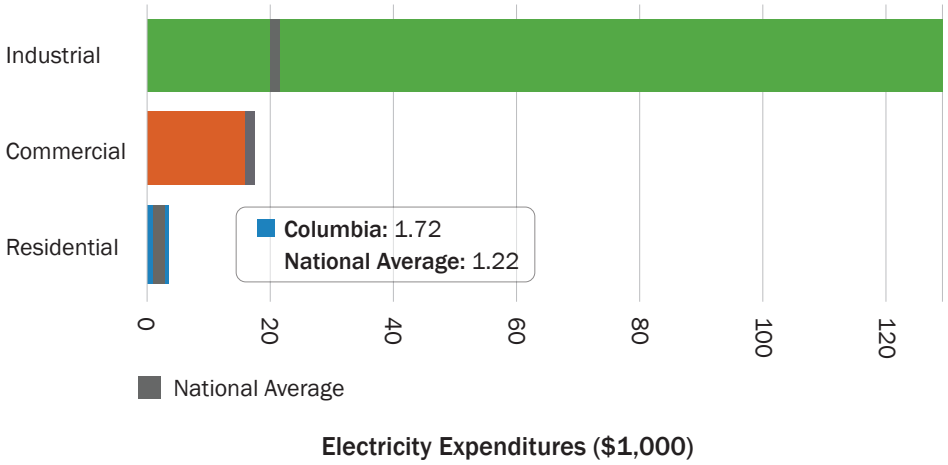


Figure 3. Per household/establishment electricity expenditures (2013) for Columbia, Missouri (Source: SLED. Scrolling over the "residential" bar online shows the Columbia and national averages.)

Electricity Cost-Saving Options

Single-family detached units comprise nearly 54% of Columbia's residential building stock by floor space area, and of this inhabited housing stock, nearly 52% is renter occupied (see Figure 4).[2] An analysis of potential energy cost savings in single-family detached homes in each state, based on a detailed modeling of 350,000 representative individual houses[3] found that the following are the most cost-effective measures in Missouri (see Figure 5):

1. Installing smart thermostats
2. Adding wall insulation
3. Upgrading to ENERGY STAR® clothes washers
4. Upgrading electric furnaces to variable-speed heat pumps at wear out.

Increased Efficiency Options

Measures to increase efficiency of low-income and rental properties include the following:

- Time of sale efficiency requirements
- Rental and low-income weatherization programs
- Mechanisms to disclose anticipated utility bills to potential renters and buyers
- Adopting the most recent building and energy efficiency codes and requiring renovations to meet code.

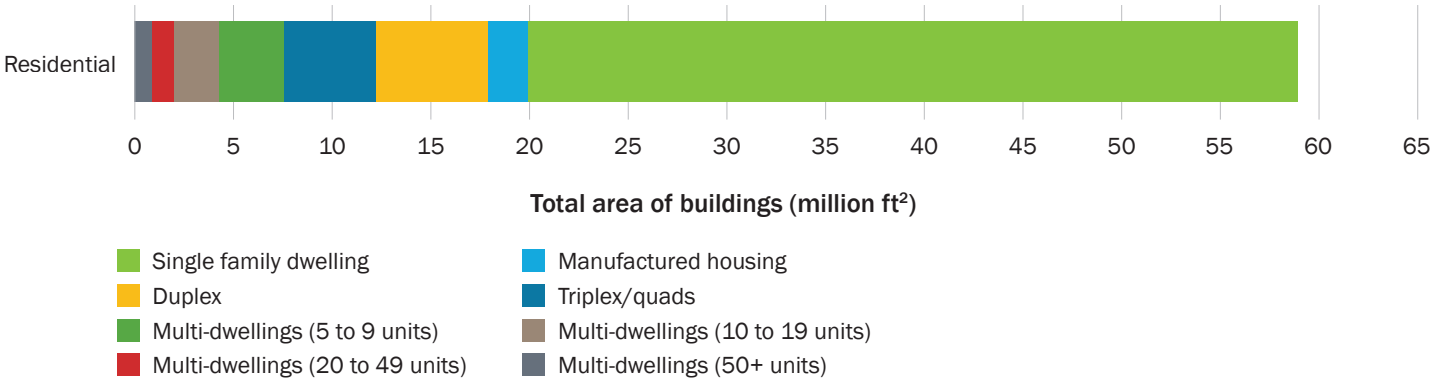


Figure 4. Residential building stock floor space area (2013) for Columbia, Missouri (Source: SLED)

[2] U.S. Department of Energy's State and Local Energy Data for Columbia, Missouri, and U.S. Census Bureau, *American Community Survey Selected Housing Characteristics, 2010–2014 American Community Survey 5-Year Estimates*.
[3] E. Wilson et al., *Electric End-Use Energy Efficiency Potential in the U.S. Single-Family Housing Stock*, National Renewable Energy Laboratory (2017), p. 91, http://www.nrel.gov/docs/fy17osti/65667.pdf.

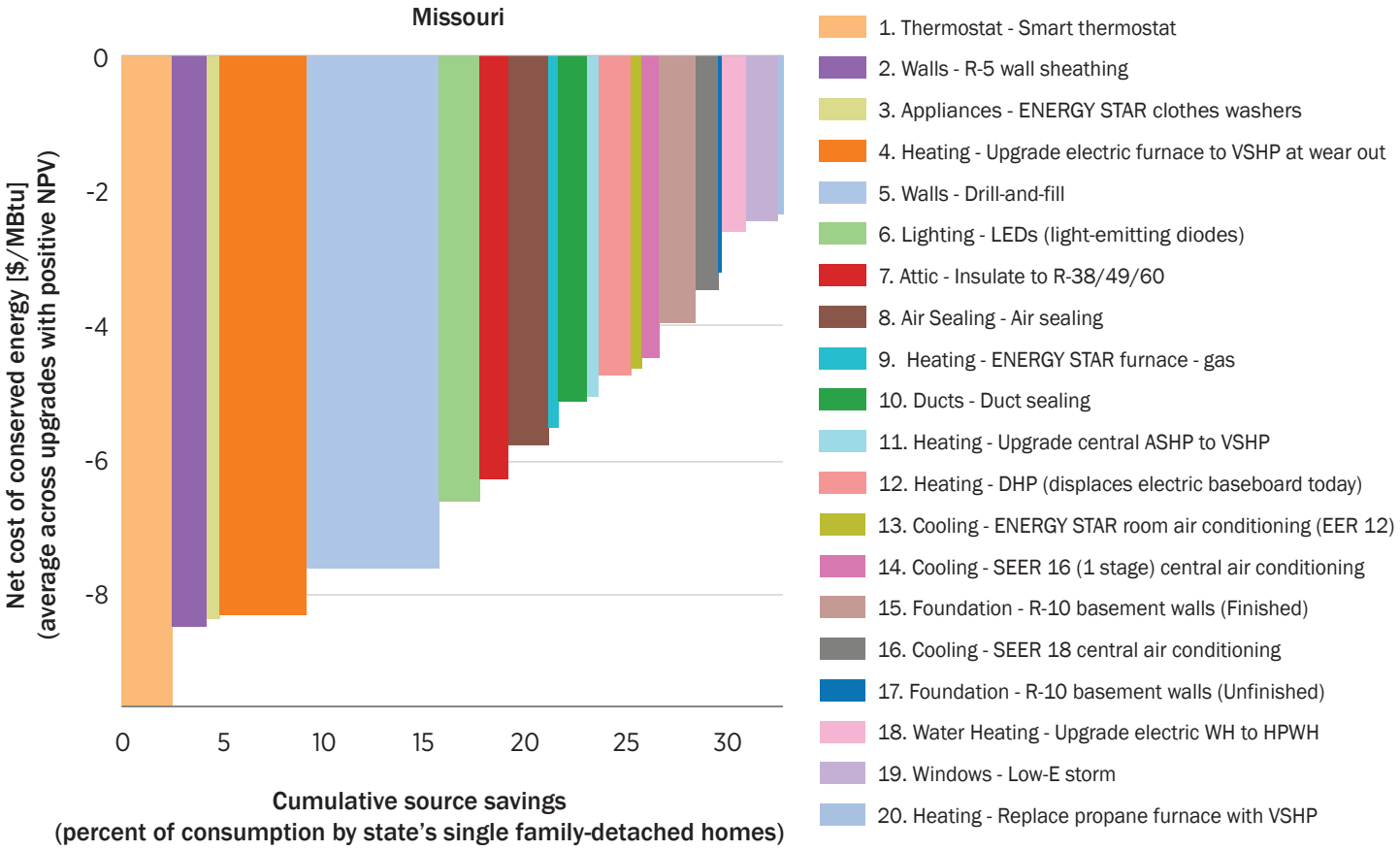


Figure 5. Energy efficiency supply curve for Missouri. (Source: Data from the NREL analysis of possible electricity cost savings in E. Wilson et al., *Electric End-Use Energy Efficiency Potential in the U.S. Single-Family Housing Stock*, NREL [2017], p. 91, *https://nrel.gov/docs/fy17osti/65667.pdf*). *NPV = net present value; VHSP = variable-speed heat pump; ASHP = air-source heat pump; WH = water heater; HPWH = heat pump water heater.*

Resources

After conducting the analysis, cities can consult additional resources and case studies to guide further research and action steps. The following resources may be useful:

- State and Local Energy Efficiency Action Network Greater Energy Savings through Building Energy Performance Policy: Four Leading Policy and Program Options: *https://www4.eere.energy.gov/seeaction/system/files/documents/building_energy.pdf*
- Local Government Climate and Energy Strategy Series, Energy Efficiency in Affordable Housing: A Guide to Developing and Implementing Greenhouse Gas Reduction Programs: *https://www.epa.gov/statelocalclimate/energy-efficiency-affordable-housing*
- Burlington, Vermont's Time of Sale Energy Efficiency Ordinance: *https://www.burlingtonelectric.com/sites/default/files/Documents/Energy_Eff/time-of-sale-energy-ordinance.pdf*
- Wisconsin Rental Weatherization Program: *http://dsps.wi.gov/sb/docs/SB-RentalWeatherizationBrochure7366.pdf*
- Maine energy disclosure requirement: *http://www.maine.gov/mpuc/online/forms/EnergyEfficiencyDisclosure.html*
- Better Buildings Low Income Accelerator: *https://betterbuildingsinitiative.energy.gov/accelerators/clean-energy-low-income-communities*
- International Green Construction Code for new and existing buildings: *http://www.iccsafe.org/international-green-construction-code/*.

The SLED Local Energy Action Toolbox provides a catalogued, searchable list of more than 500 resources: *http://apps1.eere.energy.gov/sled/cleap.html*.

Cities-LEAP is a project funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE). It is part of an effort by EERE's Strategic Priorities and Impact Analysis Team to empower state and local decision makers with data-driven analysis. ■

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DOE/EE-1556 • September 2017