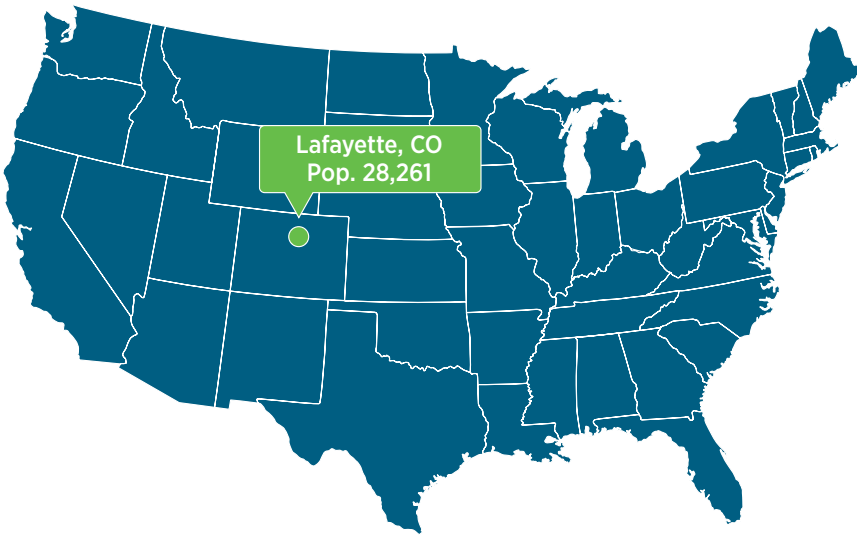
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Lafayette, Colorado: Using Energy Data for Electric Vehicle Infrastructure Planning



The City of Lafayette 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.

City Energy Questions

To inform local goal setting and infrastructure planning, the City of Lafayette, Colorado, sought data and analysis to address the following questions:

1. How does existing electric vehicle (EV) charging infrastructure align with EV ownership?

2. What steps could the city take to build EV infrastructure to meet future needs?

> "Lafayette embraces its role as a local government leader in emission reductions and decarbonization of the transportation sector by shifting to renewable fuel sources. The DOE Cities-LEAP and SLED data and analysis will enable Lafayette to develop EV infrastructure more strategically to encourage EV market growth in the community."
>
> *— Christine Berg, Mayor of Lafayette, Colorado*

Data and Analysis

To conduct the analysis for Lafayette, NREL evaluated the estimated city energy data available on SLED, supplemental data from publicly available sources, and data inputs obtained directly from the City of Lafayette.

Electric Vehicle Ownership and Infrastructure

Of the approximately 25,500 light-duty vehicles registered in Lafayette in 2015, about 0.23% were EVs (nearly double the national average[1]) and another 3% were hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs) (see Table 1). Although EVs remain a small percentage of the total registered vehicles in Lafayette, they nearly doubled from 2013 to 2014 and nearly doubled again in the following year.

DOE's Alternative Fuels Data Center (AFDC), available through SLED, indicates that there are currently eight public EV charging station locations in Lafayette (see Figure 1), seven that

Table 1. Composition of Light-Duty Vehicle Registrations in Lafayette[2]

Fuel	2013	2014	2015
Diesel and biodiesel	2.46%	2.50%	2.72%
Electric	0.07%	0.12%	0.23%
Flex Fuel	3.80%	4.09%	4.73%
Gasoline	91.17%	88.86%	89.55%
Hybrid (electric and gas)	2.78%	2.86%	3.02%
Unknown	0.57%	0.51%	0.50%

Source: In-house R.L. Polk & Company data.

[1] DOE Energy Information Administration, Annual Energy Outlook, 2017, https://www.eia.gov/outlooks/aeo.

[2] Cities can find registered vehicle fuel type data for their city on SLED.

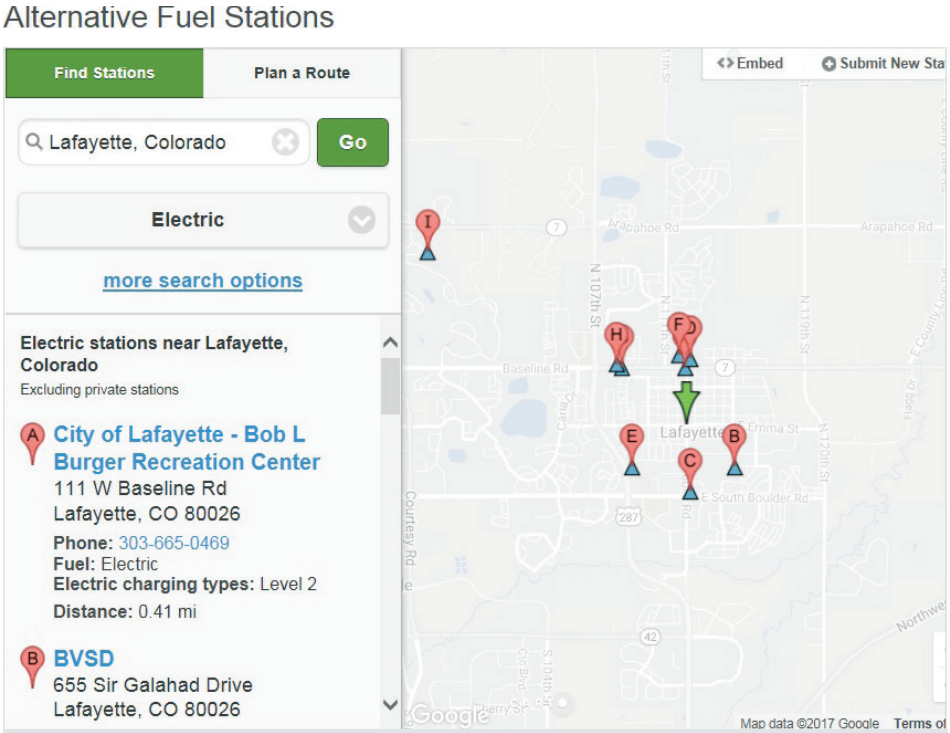


Figure 1. Electric vehicle charging stations (8 total) in Lafayette, Colorado (Source: Transportation tab of the SLED city energy profile for Lafayette [*eere.energy.gov/sled*]; original source is the AFDC [*afdc.energy.gov*])

have Level 2 charging and one with both Level 2 and direct current (DC) fast charging. Level 1 charging stations are standard 120-volt electrical outlets. Level 2 charging supplies 240 volts of alternating current (AC) electricity (the same used for household dryers and electric ovens) or 208 volts and enables reduced charging times. DC fast charging stations are more expensive to install, but they can provide 50 to 70 miles of range per 20 minutes of charging.[3]

There is limited information available to assess an ideal ratio of the number of EVs to public charging stations. However, a 2017 NREL analysis of regional charging infrastructure noted that by the end of 2015, the average U.S. county hosted about 43 public charging stations for every 1,000 registered EVs.[4] In comparison, Lafayette has three times more public charging stations per EV.

Fuel Efficiency

At 23.5 miles per gallon, the average combined fuel economy for light-duty vehicles registered in Lafayette is higher than the 21.8 miles per gallon average for U.S. cities, according to an NREL analysis of R.L. Polk & Company 2013 data. According to NREL's analysis, Lafayette also ranks in the top 10% of cities for percentage of registered HEVs (in the top 500 out of more than 23,400 cities), which may indicate a higher likelihood that residents will pursue EVs in the future.[5]

Demographic Indicators

A forthcoming NREL study[6] reveals that increasing charging station density by one per 100,000 drivers corresponds to a 3.2% increase in plug-in EV purchases. Improved access to charging infrastructure reduces range anxiety;[7] thus, any expansion to Lafayette's existing EV charging infrastructure could result in increased EV purchases.

Demographic characteristics—particularly, age, income, and educational attainment—are also correlated with EV purchases (see Table 2). The same forthcoming NREL study indicates that a

Table 2. Demographic Factors in Lafayette Compared to U.S. Averages

Demographic Indicator	Lafayette	Colorado	United States
Income: Median household income ($)	$70,714	$60,629	$53,889
Education: Percent of population with bachelor's degree or higher	55.0%	38.1%	29.8%
Age: Percent of population 18 years old or greater	76.5%	76.5%	76.7%
Age: Median age (years)	38.7	36.3	37.6

Source: Data from the U.S. Census Bureau, 2015 American Community Survey: *https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml*.

[3] "Developing Infrastructure to Charge Plug-In Electric Vehicles," Alternative Fuels Data Center, https://www.afdc.energy.gov/fuels/electricity_infrastructure.html.
[4] E. Wood, S. Raghavan, C. Rames, J. Eichman, and M. Melaina, *Regional Charging Infrastructure for Plug-In Electric Vehicles: A Case Study of Massachusetts*, NREL (2017), http://www.nrel.gov/docs/fy17osti/67436.pdf.
[5] HEV ownership has been identified as a significant indicator of future EV purchases. See C. Johnson and D. Hettinger, Geography of Existing and Potential Alternative Fuel Markets in the United States, NREL (2014), http://www.afdc.energy.gov/uploads/publication/geography_alt_fuel_markets.pdf.
[6] E. Narassimhan, and C. Johnson, NREL (forthcoming).
[7] Range anxiety refers to consumers' discomfort with driving distances approaching an EV's maximum range and the lack of opportunity to recharge the battery.

1% increase in median age corresponds with a 1.2% increase in PHEV purchases. Similarly, a 1% increase in the number of college graduates yields a 1% increase in PHEV purchases. Lafayette residents have higher levels of both educational attainment and median household income than state and national averages.

Based on income and education statistics, combined with relatively high existing HEV registrations and steadily increasing EV registrations between 2013 and 2015, Lafayette has an above-average potential to continue to increase its number of registered EVs.

Considerations for EV Infrastructure Expansion

Charging station location is a significant consideration in expanding EV infrastructure. A nationwide survey of EV drivers conducted by Idaho National Laboratory[8] showed that approximately 78% of all charging events occur at the EV owner's home.

Where workplace charging stations are available, the share for charging events is closer to 65% at home, 32% at work, and 3% at public stations. The report concludes that EV drivers do the majority of their non-home charging at only one location—their workplace charging stations.

To inform EV infrastructure planning and needs, Lafayette can conduct a geospatial analysis to estimate current and future EV charging infrastructure needs, plan for visibility and reduced range anxiety, and determine where demand for charging may be greatest. The location-specific inputs shown in Table 3 can inform such an analysis.[9]

Commercial Sector EV Infrastructure Development

Given the impact of workplace charging stations, Lafayette may consider working with large employers in the area to increase EV infrastructure.

Table 4 identifies Lafayette's top employment sectors by employment-size classes. Lafayette hosts 15 workplaces with 100 or more employees. Health care and social assistance is the only industry in Lafayette with facilities employing more than 500 people.

EV Infrastructure Expansion Options

Actions that may encourage EV adoption and enable strategic infrastructure expansion include the following:

- Requiring charging station installation in commercial building codes and development, as well as parking regulations to integrate EV charging into multifamily buildings and larger workplaces
- Providing incentives such as density bonuses and reduced parking requirements for installing EV charging infrastructure in new developments[10]
- Connecting commercial customers with resources on charging station installation available from their utilities
- Adopting zoning ordinance amendments to allow for EV charging stations and encourage their appropriate placement
- Streamlining permitting and inspection of EV charging facilities to reduce costs and installation time[11]
- Integrating EVs into Lafayette's municipal fleet and installing charging stations at municipal properties.

Table 3. Data Inputs for EV Analysis

Priority	Data/Geographic Information System Layer	Relevance
1	Existing EV charging stations*	Show where gaps in coverage exist
2	Annual average daily traffic flows†	Show where vehicles are traveling, where coverage is needed, and where new EV infrastructure will be most visible (which can reduce range anxiety)
3	Weighted vehicle density of EVs, HEVs, and PHEVs	Indicates where EVs are registered and where they are likely to be registered in the future (may be good areas for new charging stations)
4	Demographics (age, income, education)‡	Contribute to the likelihood of future EV purchases
5	Commercially zoned property	Indicates where businesses could potentially offer EV charging stations (either for employees or customers); can be cross-referenced with vehicle density to estimate demand

* Data can be downloaded from AFDC at http://www.afdc.energy.gov/data_download.

†Some data is available through the Colorado Department of Transportation's Traffic Data Explorer: http://dtdapps.coloradodot.info/otis/TrafficData.

‡ Demographic statistics are available through the U.S. Census Bureau American FactFinder at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Mapping tools are also available: https://www.census.gov/geo/maps-data/data/tiger.html.

[8] Idaho National Laboratory, "Plugged In: How Americans Charge Their Electric Vehicles," https://avt.inl.gov/sites/default/files/pdf/arra/SummaryReport.pdf.

[9] The Automotive Deployment Options Projection Tool, developed by NREL with funding from DOE's Vehicle Technologies Office, will be another resource for estimating future light-duty vehicle sales (will be available at https://www.nrel.gov/transportation/data-tools.html; methodology documented at http://www.nrel.gov/docs/fy15osti/63608.pdf).

[10] See AFDC, Local Laws and Incentives: https://www.afdc.energy.gov/laws/local_examples.

[11] For more information, see the California Plug-In Electric Vehicle Collaborative, *Streamlining the Permitting and Inspection Process for Plug-In Electric Vehicle Home Charger Installations*: http://www.pevcollaborative.org/sites/all/themes/pev/files/PEV_Permitting_120827.pdf.

Table 4. Employment Sectors by Employment-Size Classes in Lafayette, Colorado

	Number of Establishments by Employment-Size Class									
Industry code description	Total	1–4	5–9	10–19	20–49	50–99	100–249	250–499	500–999	1,000+
Total for all sectors	**907**	**584**	**150**	**94**	**52**	**12**	**10**	**3**	**1**	**1**
Manufacturing	57	22	9	14	8	2	2	0	0	0
Wholesale trade	39	28	5	3	1	0	2	0	0	0
Retail trade	70	38	17	6	5	2	2	0	0	0
Professional, scientific, and technical services	191	151	20	15	4	0	0	1	0	0
Educational services	23	12	4	4	2	0	1	0	0	0
Health care and social assistance	122	66	25	13	11	1	3	1	1	1
Arts, entertainment, and recreation	11	7	1	2	0	0	0	1	0	0
Accommodation and food services	69	20	16	19	11	3	0	0	0	0

Source: Data from the U.S. Census Bureau, Zip Code Business Patterns by North American Industry Classification System (NAICS) codes, 2014 data, *https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t*.

Resources

The following resources may be useful to cities to guide further research and action steps on EV infrastructure planning.

Clean Cities

The U.S. Department of Energy Clean Cities program supports local actions to cut petroleum use in transportation through nearly 100 local coalitions in communities across the country. Coalitions are composed of businesses, fuel providers, vehicle fleets, state and local government agencies, and community organizations. Contact your local Clean Cities coalition for assistance with implementing alternative fuels and advanced vehicle technologies: *https://cleancities.energy.gov*.

Electric Vehicles

- The Effect of State Incentives on Plug-In Electric Vehicle Purchases: *http://www.nrel.gov/docs/gen/fy15/62884.pdf*
- Alternative Fuels Data Center: "Charging Plug-In Electric Vehicles in Public": *http://www.afdc.energy.gov/fuels/electricity_charging_public.html* – Includes handbooks on workplace charging, integrating EVs into fleets, and zoning, code, and parking ordinances
- Plugged In: How Americans Charge Their Electric Vehicles: *https://avt.inl.gov/sites/default/files/pdf/arra/SummaryReport.pdf*
- Geography of Existing and Potential Alternative Fuel Markets in the United States: *http://www.afdc.energy.gov/uploads/publication/geography_alt_fuel_markets.pdf*
- ADOPT: A Historically Validated Light Duty Vehicle Consumer Choice Model: *http://www.nrel.gov/docs/fy15osti/63608.pdf*

Case Studies and Examples

- Regional Charging Infrastructure for Plug-In Electric Vehicles: A Case Study of Massachusetts: *http://www.nrel.gov/docs/fy17osti/67436.pdf*
- California Statewide Plug-In Electric Vehicle Infrastructure Assessment: *http://www.energy.ca.gov/2014publications/CEC-600-2014-003/CEC-600-2014-003.pdf*
- City of Sunnyvale, California, requirements for electric vehicle chargers: *http://sunnyvale.ca.gov/Portals/0/Sunnyvale/CDD/Residential/Electrical%20Car%20Chargers.pdf* – Requires new construction to be wired for EVs
- City of Houston, Texas, municipal electric vehicle car sharing program: *http://greenhoustontx.gov/ev/20120822.html*
- Resources from EERE's Clean Cities EV Community Readiness projects: *https://cleancities.energy.gov/partnerships/search?project_search=Electric+Vehicle+Community+Readiness*.

Find additional resources in the SLED Local Energy Action Toolbox: *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. ■

U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

For more information, visit:
energy.gov/eere/cities

DOE/EE-1619 • September 2017