

RIGHT-OF-WAY CHARGING:

How Cities Can Lead the Way



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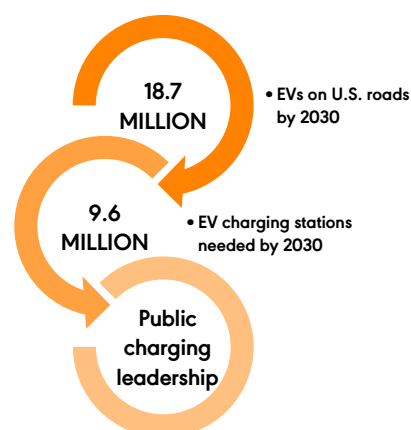
EXECUTIVE SUMMARY

The electric vehicle (EV) market is booming. By 2030, 18.7 million passenger EVs will be on U.S. roads – and they will require an estimated 9.6 million charging stations to power up.¹

Right-of-way charging will be vital to meet this demand and U.S. cities have a unique opportunity to lead the charge.

Parking spaces in the right-of-way – the area between neighboring properties, which can include street surfaces, curbs and sidewalks – are valuable and highly visible. When cities decide to install public charging equipment in these areas, it sends a clear, distinct signal of the city's desire to cut carbon and reduce emissions while simultaneously alleviating range anxiety for potential electric vehicle adopters.

This is important because it will accelerate the adoption of electric transportation. Electric vehicles produce fewer of the damaging emissions that cause



¹ ["Electric Vehicle Sales Forecast and the Charging Infrastructure Required through 2030,"](#) Edison Electric Institute and the Institute for Electric Innovation

climate change than conventional vehicles. The move to EVs can thus improve our collective health and reduce damage to our environment.

For years, American cyclists struggled to find safe, dedicated bike lanes and recreational trails. In many cities, it is now easy to find well-defined bike lanes and convenient bike parking corrals in place of car parking spaces. But this progress did not happen overnight. In 2011, there were only 78 protected bike lanes in the U.S. By 2018, the number had risen to 550 – thanks in large part to cities making the needs of cyclists a priority.²

Similarly, to address the climate crisis and support the transition to electric vehicles, cities need to make it easy to find EV charging stations. Yet as recently as 2018, it has been difficult for EV drivers to find public charging in the cities with the highest EV adoption rates. For example, Oslo – a worldwide leader in EV adoption – still struggles to provide enough charging stations in the center of the city.³

To succeed, the transportation electrification process must begin with top-level leadership. Specifically, with right-of-way charging, cities have the opportunity to lead the way.

To bring EV charging stations online, city leaders should:

- Make sure project goals align with the city's long-term vision
- Consider innovative approaches and public-private partnerships
- Clearly identify areas under consideration
- Use existing infrastructure when possible
- Include public feedback to support equity

² ["Inventory of protected bike lanes,"](#) The Green Lane Project

³ ["The Oslo model: how to prepare your city for the electric-vehicle surge,"](#) World Economic Forum

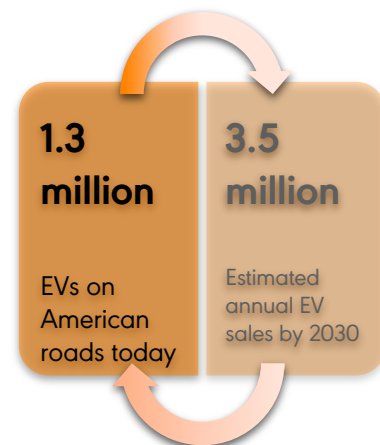


THE CASE FOR RIGHT-OF-WAY CHARGING

The ever-changing demands on public rights of way – bike-, ride-, and car-sharing services – will require additional urban design and management. It will take visionary leadership, collaboration with public and private entities, and – more than anything else – a commitment to process and progress.

Electrifying transportation is critical to addressing climate change. Cities can take active steps in addressing the climate emergency by trying to electrify transportation, starting with private passenger cars.

At the moment, there are an estimated 1.3 million electric vehicles on U.S. roads, but sales are estimated to exceed



3.5 million per year in the next decade.⁴ Adequately powering millions of EVs will require the installation of electric vehicle charging infrastructure in the public right-of-way.

Oslo, with EVs and hybrids comprising 16% of all cars,⁵ has a decent claim as the “electric vehicle capital of the world.”⁶ And Norway as a whole is on track to make a significant climate impact, with EVs making up 42% of all new car sales in 2019.⁷

In the U.S., some cities have already set a precedent for using the right-of-way to reduce greenhouse-gas emissions through their support of bike commuting, recreational cycling, and other forms of active transportation.

In Portland, Oregon, the city government has invested in bike racks, lanes on the streets and cyclist-friendly infrastructure that is now synonymous with the city.⁸ This was by design – deemed “new urbanism,” with a goal of less congestion. Likewise, if cities want to reduce air pollution and meet their carbon goals, they’ll need to push for electric vehicle charging that will be just as convenient and ubiquitous.

Prominent charging stations on the street can be an effective method of raising awareness, not unlike biking lanes and bike racks. Convenience and accessibility are important considerations.

EV CHARGING TERMINOLOGY

There are several common types of chargers and charging station models that can be used to build right-of-way charging facilities.

Level 1 charging: This type of AC charger adds about 4 miles of EV range per hour. It can take up to a full day or night to charge a vehicle. As a result, this is best used for overnight and at-home charging.

Level 2 charging: A faster option, this AC charger adds about 25 miles of range per hour.

DC fast charging: The fastest charging option. Speeds vary, but some can charge an EV in about 30 minutes.

Networked charging stations: Being part of a network allows EV drivers to find stations through a mobile app.

Curbside chargers: These stations equip curbside parking spaces with Level 2 chargers. Curbside charging is common in residential and commercial parking areas.

Lamppost chargers: Lamppost-mounted charging can work with Level 1 or Level 2 chargers. Because Level 1 charging is slower, lamppost chargers help serve those without access to home charging and are most practical where parking turnover is low.

Curbside DC fast chargers: Installing multiple DC fast chargers in one curbside location can provide a charging solution for EV owners without adequate home charging. This includes drivers who live in apartments or condos, Lyft, Uber and taxi drivers, and drivers passing through the area.

⁴ “[Electric Transportation Benefits Customers, Communities, and the Environment](#),” EEI

⁵ “[The Oslo model: how to prepare your city for the electric-vehicle surge](#),” World Economic Forum

⁶ “[Cities compete to claim title of world EV capital](#),” the International Council on Clean Transportation

⁷ “[Car sales down in 2019; electric cars are still growing the most \(translated\)](#),” OFV

⁸ “[Most bike-friendly cities in the United States](#),” CNN Travel

Many U.S. drivers cannot charge at home. They live in apartments or condominiums, or do not have access to a driveway or personal garage. To help address this issue, Portland's Affordable Housing Green Building Policy requires developers of certain city-supported multifamily and mixed-use buildings to include EV charging stations at 4% of the parking spaces on site or to be EV-ready at 10% of the parking spaces.⁹ The City of Boston signed into law the "Right to Charge," which requires building owners to allow tenants to install EV charging stations if they want to.¹⁰

Delivery vehicles and car-share drivers also would benefit from easy access to public charging stations. These drivers can travel 50,000 miles a year or more,¹¹ which is more than five times the amount driven by the average commuter.¹² Electrifying those miles is easy to justify thanks to the excellent total cost of ownership of EVs, but it's important to recognize the opportunity cost for these drivers. If they need to charge multiple times in day, they will want to do so as quickly and conveniently as possible.

⁹ ["Portland Housing Bureau Affordable Housing Green Building Policy,"](#) adopted by city council

¹⁰ ["AN ACT ESTABLISHING GUIDELINES FOR THE INSTALLATION AND USE OF ELECTRIC VEHICLE CHARGING STATIONS IN THE CITY OF BOSTON,"](#) Massachusetts Legislature

¹¹ ["Ask a driver: How many miles do Uber and Lyft drivers put on their cars?"](#) Ride Guru

¹² ["Average Annual Miles per Driver by Age Group,"](#) Federal Highway Administration



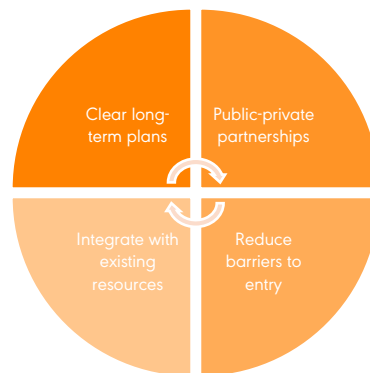
A STRATEGIC APPROACH

The most effective transportation electrification measures have buy-in from either elected or appointed leadership. If climate goals are going to be met, all new cars sold in the U.S. will need to be electric within the next decade or so.¹³

Cities can be agents of this change – what they do on an individual basis to combat climate change can have a ripple effect on the larger community.

While state and federal officials are not as nimble, local leaders can take direct and decisive action.

Mayors and city council members can embrace and accelerate EV adoption by endorsing policies in support of transportation electrification. City departments can then develop specific policies and programs to meet this goal, with clear direction and support from political leaders.



Cities' role

Installing public EV charging stations might seem like an ambitious project, but with focus and planning, it is entirely manageable. After all, cities have always accommodated new transportation modes. At the turn of the century, many cities provided horse-tethering rings

¹³ ["This is how the U.S. gets to zero percent carbon emissions by 2050,"](#) Fast Company

mounted in the curb; these gave way to streetcars, car parking spaces, and bike lanes. Similarly, cities that want clean, carbon-free transportation should seek opportunities to encourage electric vehicles by providing convenient, affordable, high-visibility charging.

Some cities may be inclined to view charging as a commercial activity to regulate, tax, or franchise, similar to telecommunications companies or private micro-mobility companies. However, public charging is unlikely to be profitable until EV adoption is considerably more widespread. We argue that cities should view charging more like bicycle infrastructure - as something that is necessary to a clean, livable, low-carbon transportation system. Cities have a key role to play in making charging - and clean electric vehicles - available to their citizens.



A horse-tethering ring, used in the turn of the century, remains mounted in the curb in present-day Portland, Oregon.

For example, Amsterdam – one of the most advanced cities in the world in terms of the promotion of bicycling – is a global leader in promoting transportation electrification. The city has installed hundreds of on-street EV chargers, with thousands more planned.¹⁴

Think big, start small

When cities are ready to take action, it pays to approach right-of-way charging strategically, with an eye toward long-term planning and partnerships with key stakeholders.

Working closely with a local electric utility and with private charging companies is ideal. At the current pace, mobility technologies and needs are in a constant state of evolution. It can therefore be effective to form a cross-functional stakeholder group to brainstorm ideas and evaluate concepts to ensure any decisions are relevant to the current circumstances. This will inform the strategy the city should take related to charging in the right-of-way.

For example, charging can be integrated with high-efficiency lighting, mounted on power poles, combined with parking control systems, or integrated into multimodal “mobility hubs.” Some companies offer free charging services supported by advertising. Some operate smart networks that generate valuable data, and others simply sell non-networked hardware.

There are a variety of technologies and business models that should allow cities to develop a strategy that supports their other mobility priorities (see Table 1).

TABLE 1: SUMMARY OF PUBLIC CHARGING OWNERSHIP MODELS

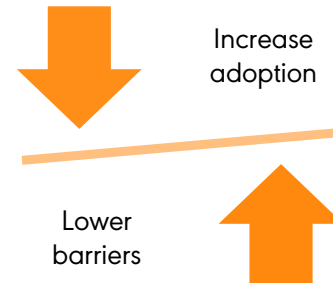
Ownership	Cost to city	City revenue
Third-party owned and operated	Low: program management costs	Low
City-owned, third-party operated	Medium: hardware and management costs	Medium
City-owned and operated	High: hardware, operation, and management costs	High (but unlikely to break even)
Leasing or charging as a service (CaaS)	Medium: subscription fee	Shared revenue with third-party
Advertising-supported free charging	Low	Small monthly site host payment

¹⁴ [“Total to install and operate 20,000 new EV charging points in Amsterdam,”](#) Science Business

Learn from early adopters

While carbon-reduction goals require large-scale EV adoption in the coming decade, there also need to be plans, mechanisms and processes in place now to prepare for the future.

Cities need not rush to tear up streets simply to install charging, though. Instead, they can learn from early-adopter cities that have begun to incorporate charging into their long-term transportation system plans for the urban streetscape, adding charging as part of a defined process as streets are renovated along with lighting, sidewalks, bike lanes, and other aspects of modern urban mobility.



Be as clear as possible with your plans. Make sure the parameters and processes are simple and well-conveyed in order to minimize the transaction costs for participants.

Sometimes, the most impactful step a city can take is to get out of the way by reducing permitting or planning barriers or identifying specific locations for innovation.

Small pilot programs that are fast, easy to understand and well-defined are a good start before launching a project that may be overly ambitious.



BARRIERS AND CHALLENGES

When considering right-of-way charging projects in your city, it pays to anticipate potential pain points and to prepare to meet these challenges head-on.

Barriers to public charging station projects may include:

Placement of chargers in the right-of-way. Identifying where to place and install chargers in the right-of-way can be a laborious task. Chargers cannot be located in areas designated for a future bike or bus lane. Ideal, high visibility locations may be far from available utility tie-ins, which can also add to project costs.

Construction and permit timelines. The timeline to complete planning, construction, and commissioning of chargers in the right-of-way can be prohibitive in terms of both cost and timing. Permits are necessary to close roads and sidewalks at the project site. Inspectors unfamiliar with the new technology may need supporting documentation and additional time to approve a

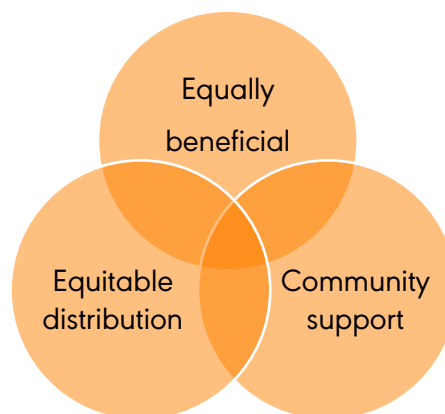
permit. Numerous projects have been cancelled due to the excessive lag between construction and opening.

Establishing and enforcing parking policies. Prior to making an investment in charging hardware, the owner will likely calculate the return on investment (ROI), assuming the utilization rate and number of charging sessions. The number of charging sessions is directly associated with parking enforcement, getting vehicles to move after an allotted amount of time or once their car is charged. Parking enforcement officials should be trained to understand the new chargers' technology and associated rules or policies.

Internal stakeholder engagement. Internal city stakeholder engagement is crucial when implementing a new charging project or program in the right-of-way, but it can be taxing. Getting the right people – representatives from various city departments or bureaus – in the room during the project planning process takes time to coordinate and requires a certain amount of convincing from the outset.

Community engagement and equitable distribution.

The city is responsible for ensuring the surrounding community supports new charging infrastructure in the right-of-way. The city should ask, "Who does this benefit?"; "Is this reinforcing historic or institutional systems of racism and/or contributing to gentrification?" In addition, programs that will place chargers in the right-of-way throughout the city should consider equitable distribution. It's important to make sure all of the charging stations do not end up in one area based solely on the current adoption of EVs, as adoption rates will change over time.



Advertising restrictions in the right-of-way. Depending on the jurisdiction, information on chargers, including logos and signage, can be considered advertising. If there are advertising restrictions in the right-of-way, this can become a barrier for many charging companies. In some instances, it may affect or negate the business model of the charging provider. Depending on the provider, advertising may be key to the business model for offering free or reduced charging to consumers.



RECOMMENDATIONS AND BEST PRACTICES

Cities across the United States have developed a number of right-of-way charging solutions. The following best practices can help build consensus, streamline the application and permitting process, and drive adoption of right-of-way charging in your community.

Program design recommendations

Align your program with your city's long-term vision and strategic plan. To encourage buy-in and ensure a smooth process, right-of-way charging stations should be installed in locations that align with the larger planning and goals of your city. For example, charging stations are not recommended in areas where the city has plans for conflicting public improvements such as bike lanes or transit stops.

Understand the program's impact and audience before selecting charging technology. Right-of-way charging stations will serve a mix of residents, commuters and visitors. Coordinate and consult with community needs as you develop your program design.

For example, consider the needs of a high-traffic, dense urban area compared to those of a single-family residential neighborhood. Level 2 chargers may be a cost-effective solution for relatively fast residential service, while DC fast charging may be more appropriate for EV owners who cannot park a car for the two to four hours that Level 2 charging requires.

CASE STUDY

Charlotte, North Carolina



The City of Charlotte is using Automated Vehicle Locator (AVL) data to inform where chargers are needed for fleet use. Additionally, the city will use semi-mobile, solar-powered EV chargers to scout new areas for installation. The chargers do not need to be connected to the grid and can be moved from one neighborhood to another to test whether they are appropriate to be used in each location prior to expensive investments in charging infrastructure.

A local university recently approached the city to explore the possibility of installing EV charging stations on streetlights. If a pilot project were approved, it would likely start in 2021.

Pre-select areas where right-of-way charging will be considered. This helps staff avoid reviewing applications for permits in neighborhoods where there are known conflicts with the city's long-term land use and zoning plans. Clearly communicate the areas under consideration to permit applicants.

CASE STUDY

San Jose, California



The City of San Jose is using California Department of Motor Vehicle data to map where right-of-way charging facilities are currently. This has shown that most charging stations are concentrated in more affluent areas. The city plans to [invest \\$3.5 million in low-income communities](#) to ensure equitable distribution of public charging stations.

Ensure that applicants are ready to build soon after permit approval. Limit the amount of time that successful applicants can place a hold on parking spots and the adjacent curb space. This

prevents potential permit abuse by applicants who retain the parking area before they are ready for construction.

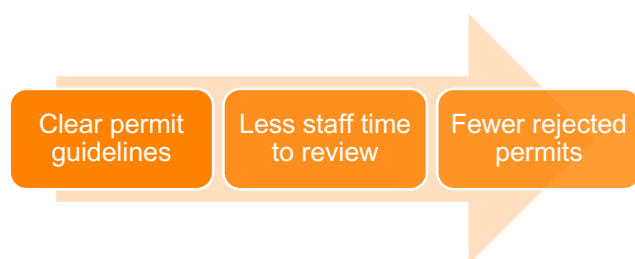
Balance parking and charging demands in residential neighborhoods. Curbside right-of-way charging stations in residential areas will allow EV drivers to charge near their homes. But restricting parking spots in areas that have heavy curbside parking demands may have a negative impact on the neighborhood.

Consider longer-term, easily renewable permits for charger installation. Regulatory certainty is essential to attract investment in EV charging stations. Simplifying the permit process will encourage applicants and increase their confidence in the viability of their investment.

Identify a single point of contact for your program. This person should know all of the key stakeholders and be able to answer questions during the application process. Create a dedicated email address and phone number for the point of contact and post it prominently on your program website.

Permit process recommendations

Clearly outline the permit application process and requirements. A program that is meant for residential curbside charging stations will likely not have the same process or requirements as a program meant for curbside DC fast chargers in mixed-use and commercial areas.



A clear guide to your process will save staff time and increase the number of applications that pass initial review. The more educated your applicants are about your permit requirements and situations that will lead to rejection, the less time the city

will need to spend reviewing applications and issuing revisions. (See Appendix 2 for examples of permit workflows.)

Educate applicants about all potential costs. The right-of-way charging process can be expensive. Processing applications and permits takes time, and installation may require significant investment due to service panel upgrades, trenching, distance from the electrical pole, and various other constraints. Ensure that applicants are aware of all expected costs – including the application, relevant permits, and the estimated project costs of the entire installation.

Incorporate public opinion into the permit review process. Community outreach and engagement can build goodwill for charging stations. While right-of-way charging is essential for

people who don't have access to chargers at their homes or workplaces, some community members worry about the gentrifying impact of charging stations. These stakeholders are concerned that the installation of right-of-way charging could boost local property values or increase rents. To allow their voices to be heard, consider requiring a 14-day public notice and comment period before reviewing permits. This public feedback can then be incorporated into the application approval process.

CASE STUDY

Seattle, Washington



From 2017 to 2019, the City of Seattle operated an [Electric Vehicle Charging in the Right-of-Way Permit Pilot](#). The pilot supported how the city assessed the permitting process, equipment installation and associated challenges, and equity considerations. (For an overview of the process, see Appendix 2.)

The evaluation process for permit applications included a diverse group of stakeholders and staff; it also included the Seattle Department of Transportation's [Human Centered Design Study on Equitably Expanding the EV Charging Network](#).

Signage and enforcement recommendations

Use signage to communicate charging costs and parking rules. Eye-catching signage and painted parking spots are critical to grabbing attention and deterring non-EV drivers from occupying right-of-way charging spaces. Make sure your signs succinctly explain the rules, rates, and fines if rules are broken. Your signage also should be compatible with its environment and resistant to vandalism, wind, rain, or extreme temperatures. (For examples of effective signage, see Appendix 3.)

Educate parking enforcement staff so they understand how charging stations work. Enforcement of your city's parking and charging policy is critical to cultivating appropriate behaviors. Time limits should be enforced, possibly by requiring EVs to park only while charging. Adding idle fees for those who remain parked after charging can be an effective solution. Plan to train your parking enforcement officers in EV charging technology so that they can address other parking situations as they arise.

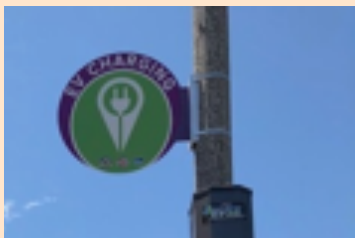
Technology recommendations

Consult electric utilities to make sure the grid can support charging stations. Work with your local electricity provider to make sure that there is adequate power at your selected project sites and that planned grid infrastructure upgrades won't affect your proposed charging stations. You may wish to partner with your utility to identify a list of pre-screened locations that are appropriate for right-of-way charging.

Use retrofitted light posts to make use of existing infrastructure. EV chargers connected to light posts can be an effective solution to providing right-of-way charging in public areas. Light posts that have recently been retrofitted with efficient LED fixtures generally have excess power capacity that can be channeled to an EV charger for Level 1 or Level 2 charging.

CASE STUDY

Los Angeles, California



For three years, the [City of Los Angeles Bureau of Street Lighting](#) has been installing networked low Level 2 charging stations on street lights that were upgraded to LEDs, thus providing excess electrical capacity. There are now more than 280 street light charging stations installed. The chargers are equally distributed in all 15 council districts.

Each street light has the capacity for a single charging station, and each charging station can reach a single parking spot. In the past year, an ordinance was passed that allows Los Angeles' parking enforcement officers to ticket gas vehicles or EVs that are not plugged in when they park at the charging spots.

Install electric avenues to reduce range anxiety. Placing multiple DC fast chargers in dedicated right-of-way parking areas is a popular solution for EV owners without dedicated chargers at home. These "electric avenue" charging stations require many stakeholders, often depend on significant utility backing, and must be in a convenient location. However, electric avenues often

single-handedly convince EV drivers without dedicated charging that they can easily power their vehicles to sufficiently reach their destinations.

CASE STUDY

Portland, Oregon



Throughout 2018 and 2019, the City of Portland partnered with a local electric utility, Portland General Electric, to facilitate the opening of four [electric avenue hubs](#) around the metro area. Three more are planned for 2020.

Each station features four DC fast chargers and two Level 2 chargers. The downtown Electric Avenue has become a staple for Portland-based EV drivers who need to charge their vehicles.

ACKNOWLEDGEMENTS

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This paper was developed through interviews with many individuals and institutions that work on charging in the right-of-way. We appreciate the time and insights offered by the Cities of Los Angeles, California; Seattle, Washington; Sacramento, California; Charlotte, North Carolina; St. Paul, Minnesota; Portland, Oregon; and San Francisco, California.

APPENDIX 1

Resources and works cited in this paper include:

- Carbon Brief, "[Factcheck: How electric vehicles help to tackle climate change](#)"
- City of Los Angeles Bureau of Street Lighting, "[EV Charging Stations](#)"
- City of Portland, "[Portland Housing Bureau Affordable Housing Green Building Policy](#)"
- City of Sacramento, "[Curbside Charging](#)"
- City of Seattle, "[Electric Vehicle Charging in the Public Right-of-Way Pilot Program](#)"
- CNN Travel, "[Most bike-friendly cities in the United States](#)"
- Edison Electric Institute and the Institute for Electric Innovation, "[Electric Vehicle Sales Forecast and the Charging Infrastructure Required through 2030](#)"
- EEL, "[Electric Transportation Benefits Customers, Communities, and the Environment](#)"
- Envision Solar, "[EV Autonomous Renewable Charger \(ARC\) technology](#)"
- Fast Company, "[This is how the U.S. gets to zero percent carbon emissions by 2050](#)"
- Federal Highway Administration, "[Average Annual Miles per Driver by Age Group](#)"
- National Oceanic and Atmospheric Administration, "[Climate Change: Global Temperature](#)"
- OFV, "[Car sales down in 2019; electric cars are still growing the most \(translated\)](#)"
- Portland General Electric, "[Electric Avenue](#)"
- Ride Guru, "[Ask a driver: How many miles do Uber and Lyft drivers put on their cars?](#)"
- San Francisco Chronicle, "[Californians are buying up electric cars. But where will they plug in?](#)"
- San Jose Inside, "[City of San Jose Plans to Double Electric Car Charging Stations with \\$14 Million Investment](#)"
- Science Business, "[Total to install and operate 20,000 new EV charging points in Amsterdam](#)"

Seattle Department of Transportation, "[Human Centered Design Study on Equitably Expanding the EV Charging Network](#)"

The Green Lane Project, "[Inventory of protected bike lanes](#)"

The International Council on Clean Transportation, "[Cities compete to claim title of world EV capital](#)"

UC Davis Plug In Hybrid and Electric Vehicle Research Center, "[A review of consumer preferences of and interactions with electric vehicle charging infrastructure](#)"

World Economic Forum, "[The Oslo model: how to prepare your city for the electric-vehicle surge](#)"

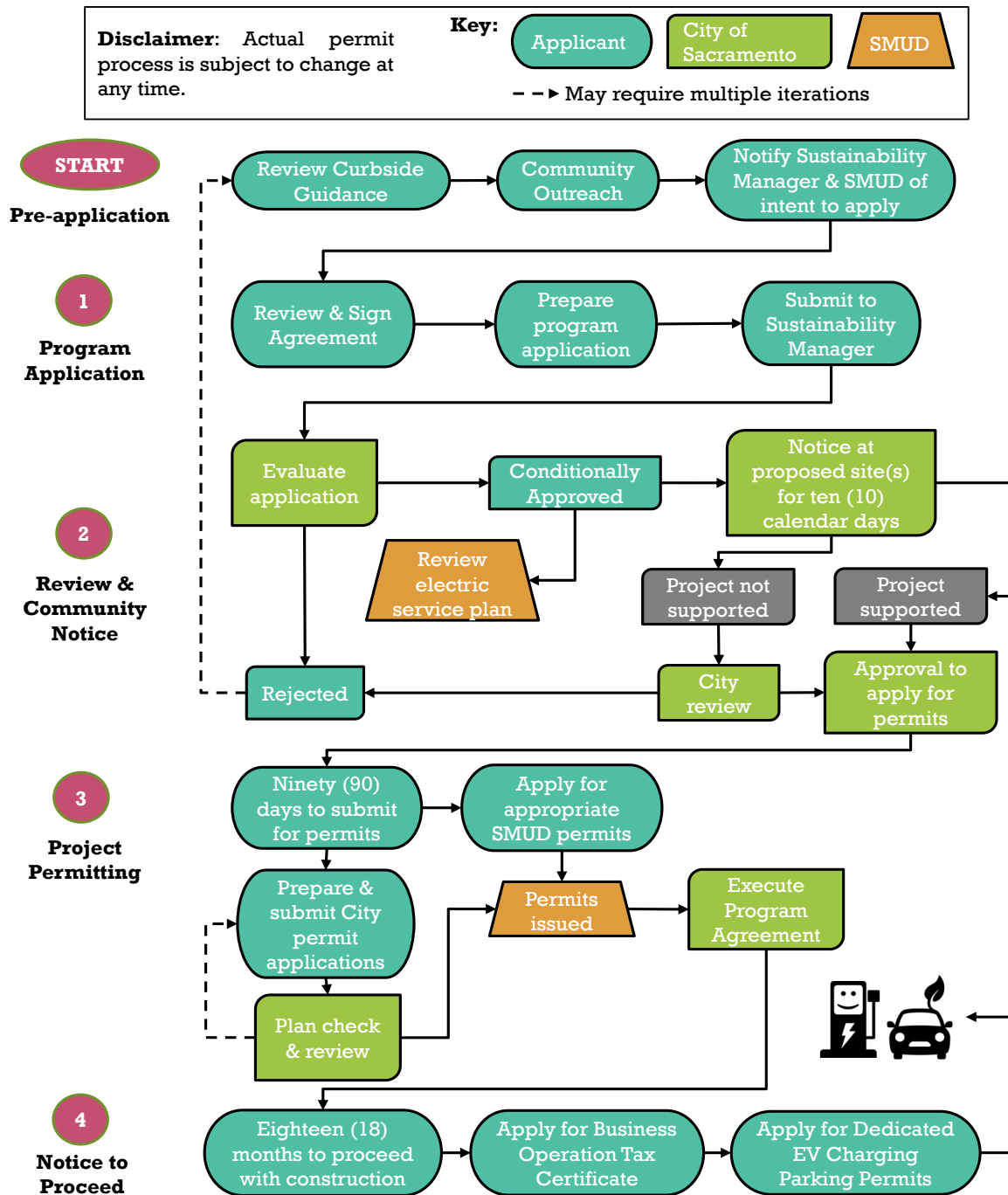
APPENDIX 2

The following flowchart outlines the City of Sacramento's [right-of-way permitting process](#).

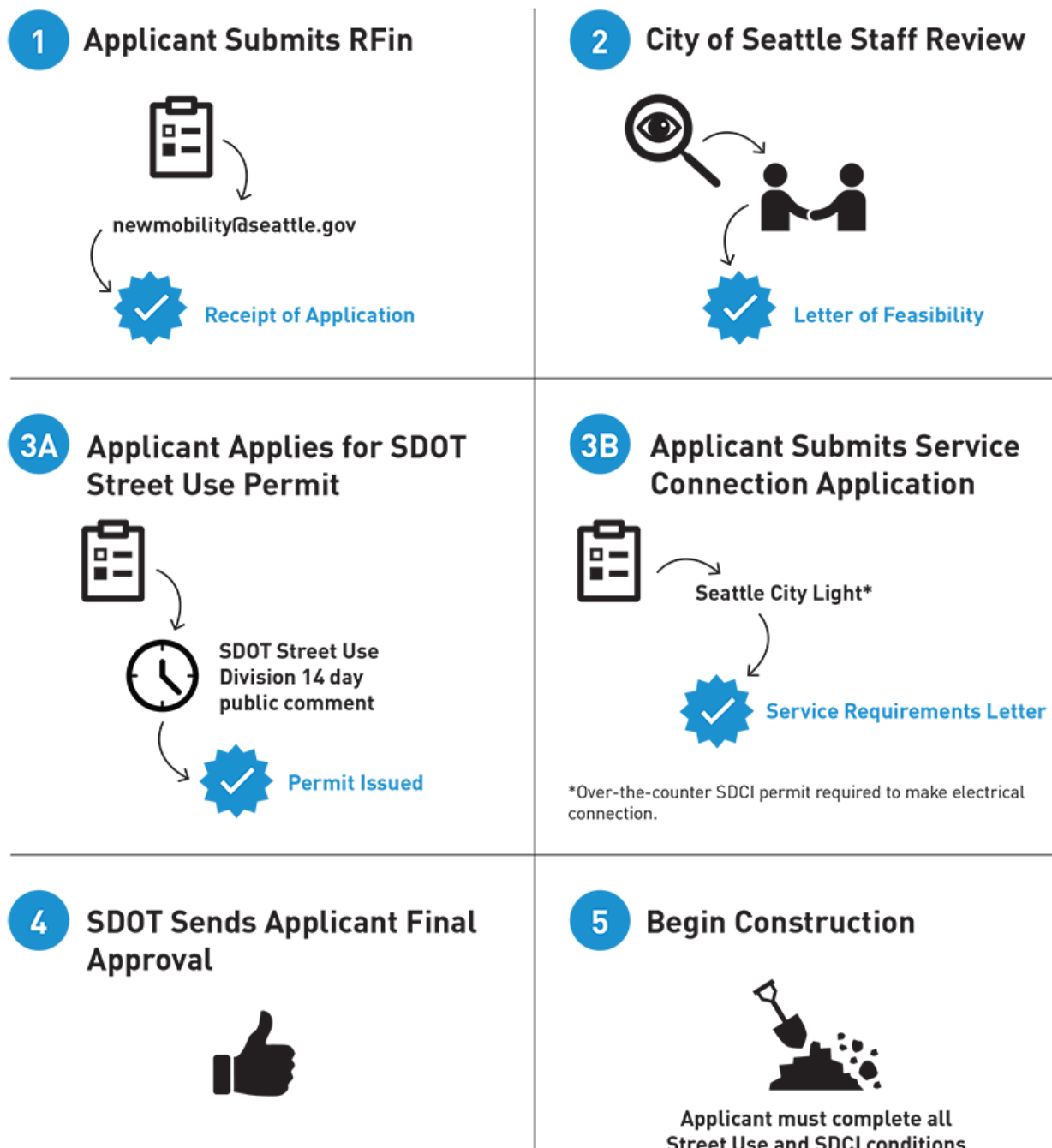
PUBLIC DRAFT: JUNE 2018

City of
SACRAMENTO

Curbside EV Charging Pilot: Permit Process



Similarly, the City of Seattle guides applicants through the permitting process for its [Electric Vehicle Charging in the Public Right-of-Way Pilot Program](#) using the following infographic.



APPENDIX 3

U.S. Department of Energy's Alternative Fuels Data Center offers [simple guidance for developing appropriate charging station signage](#). Effective wayfinding and parking signs can:

- Help EV drivers find and navigate to right-of-way charging stations
- Optimize charging station use helping all drivers understand that parking at charging stations is for EVs only
- Provide information about charging station access, time limits and hours of use
- Facilitate parking enforcement at right-of-way charging stations

The AFDC offers the following examples of appropriate signage for EV charging stations:

