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Global EV city leaders: Accelerating the EV transition in a year of disruption

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Executive Summary

This research assesses the 25 largest plug-in electric vehicle markets at the metropolitan level in 2020, which together represent 32% of 2020 global new electric vehicle sales and 34% of global electric passenger vehicles on the roads. We analyze their electric vehicle uptake, charging infrastructure development, electrification goals, planning, and incentives to draw lessons to assist local governments in their transition to electric mobility.
Keywords: *EV (electric vehicle), EVSE (Electric Vehicle Supply Equipment), incentive, market development, municipal government*

1 Motivation

Despite the 15% drop in vehicle sales worldwide in 2020 due to the global pandemic, the electric vehicle (EV) market continued to grow, with a 42% increase in EV sales compared to 2019 [1]. There were over 3 million new electric cars and trucks sold in 2020 (including battery electric vehicles [BEVs] and plug-in hybrid electric vehicles [PHEVs]), representing 5% of the global new car market. While governments like those in China, the European Union, and California have implemented many of the guiding policies for this early growth, local governments have often set bolder goals and created unique new policies, resulting in significantly higher uptake within specific local markets.

This research investigates which cities around the world have the greatest electric vehicle sales in 2020. Building on a multi-year series of reports [2], we highlight 25 leading metropolitan areas in absolute number of new light-duty electric passenger vehicle registrations in 2020: Beijing, Changsha, Chengdu, Chongqing, Guangzhou, Haikou, Hangzhou, Liuzhou, Shanghai, Shenzhen, Suzhou, Tianjin, and Zhengzhou in China; Amsterdam, the Netherlands; Bergen and Oslo, Norway; London, United Kingdom; Paris, France; Stockholm, Sweden; Stuttgart, and Munich, Germany; Seoul, South Korea; and Los Angeles, San Francisco, and New York in the United States [3]. For each of these metropolitan areas, we discuss electric vehicle sales, charging infrastructure deployment, and incentive policies to promote electric vehicles. We discern lessons from these leading cities that can help to accelerate market growth in other cities.

In this paper, new electric vehicle registrations are considered a proxy for new electric vehicle sales. In some cities, many cars may be registered by vehicle manufacturers (Daimler in Stuttgart and BMW in Munich, for example) or other large fleets, but may be moved and used elsewhere. For example, company cars and rental cars may be registered at company headquarters but used in other locations.With lack of data on usage versus registration location, all cars are attributed to their registration location.

2 Electric vehicle uptake

Figure 1 presents the 2020 registrations distinguished between plug-in hybrid (light blue) and battery electric (dark blue) vehicles for the left axis and the 2020 electric registrations share (red diamond and right axis) [4]. Altogether, these cities represent 32% of 2020 global electric vehicle registrations and 13% of 2020 global passenger vehicle registrations, yet only 4% of the world's population.

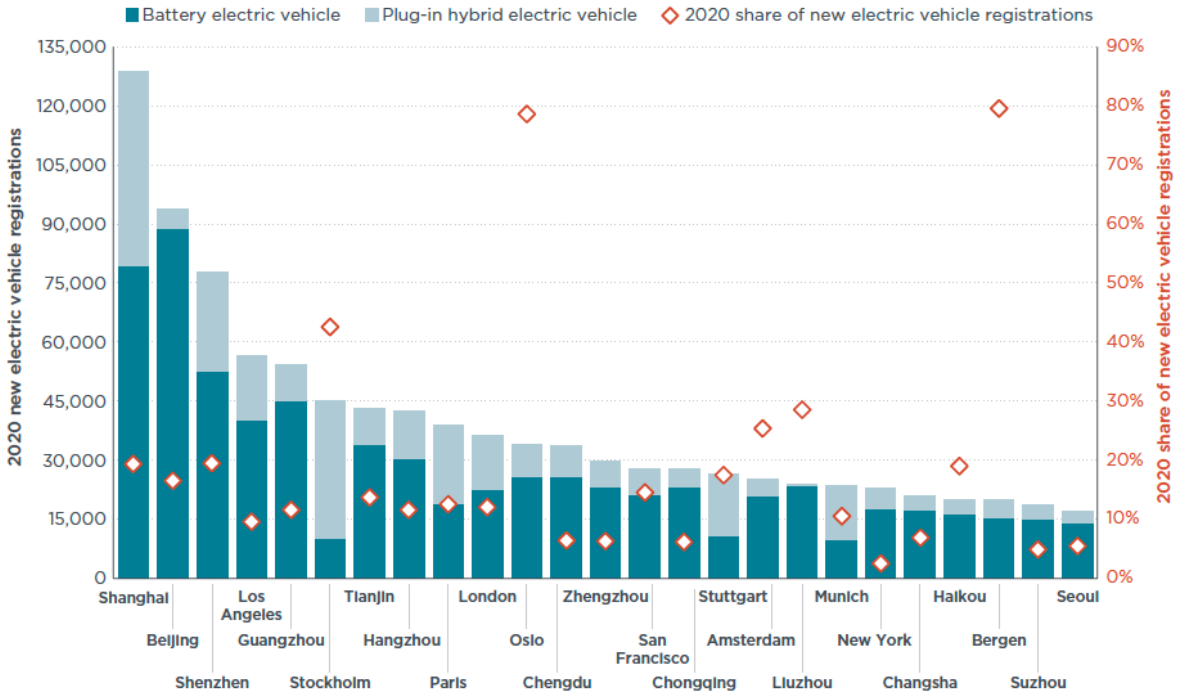

Figure 1: New electric vehicles registered in 2020 (left axis) and electric vehicle registrations share (right axis) for the 25 selected leading markets

Each of the leading markets had more than 17,000 new electric vehicles registered in 2020 representing between 2.5% (New York) and 80% (Bergen) of their respective total passenger car registrations. Shanghai led in absolute EV registrations with close to 129,000 units, of which 79,500 are battery electric vehicles, followed by Beijing (93,600 units) and Shenzhen (77,900 units). When focusing on battery electric vehicle registrations, Beijing led with 88,900 units.

In terms of the electric vehicle share of new vehicle registrations, European cities were leading, with EV registration shares of at least 10.5% in 2020. The two Norwegian cities, Bergen and Oslo, maintain a large lead in registration share with both close to 80%, followed by Stockholm (Sweden) with 43% and Liuzhou (China) with 29%. 17 of the highlighted leading markets had EV registration shares above 10%, compared to 13 in 2019.

2.1 Composition of the EV market by powertrain

The composition of EV markets by powertrain varies across the 25 metropolitan areas. In 21 cities BEVs were the most popular type. BEVs accounted for more than 80% of new EV sales in 9 cities: Amsterdam, the Netherlands; Beijing, Changsha, Chongqing, Guangzhou, Haikou, Liuzhou, and Suzhou China; and Seoul, South Korea. In contrast, in 4 European cities, (Munich and Stuttgart, Germany; Paris, France; and Stockholm, Sweden), PHEVs were the majority of EV sales in 2020.

The higher PHEVs shares can be explained by multiple factors, including high PHEV subsidies, a large number of credits allocated to PHEVs in the European CO_2 standards, some European manufacturers producing more PHEVs than BEVs, and a large share of company cars for which the fuel is paid by the company and not necessarily the home electricity. It is important to differentiate between plug-in hybrid electric vehicles and battery electric vehicles when describing the plug-in vehicle market. Indeed, according to a 2022 study analyzing the German market, while BEV life cycle GHG emissions are, on average, 63% lower than their gasoline counterpart, PHEVs offer only a 34% reduction. In contrast to BEVs, PHEVs are not able to meet the long-term requirements of a climate-neutral passenger car fleet [5].

3 Charging infrastructure

Electric vehicle charging infrastructure is one of the most important factors in transitioning to electric mobility and local governments have a critical role to play in its rollout. The deployment of public electric vehicle charging varies widely among the 25 metropolitan areas highlighted based on differences in underlying demographics, housing, and transportation behavior along with local policies and strategies.

Figure 2 illustrates the amount of public charging available in the leading cities where data were available using several metrics: the absolute number of public charge points (left), the number of public charge points per million population (middle), and the number of electric vehicles per public charge point (right). These are further disaggregated into normal (AC, <50 kW in brown) and fast (DC, >40 kW in blue) charging. Metropolitan areas are ordered by markets and then decreasing number of public chargers per million population from top to bottom.

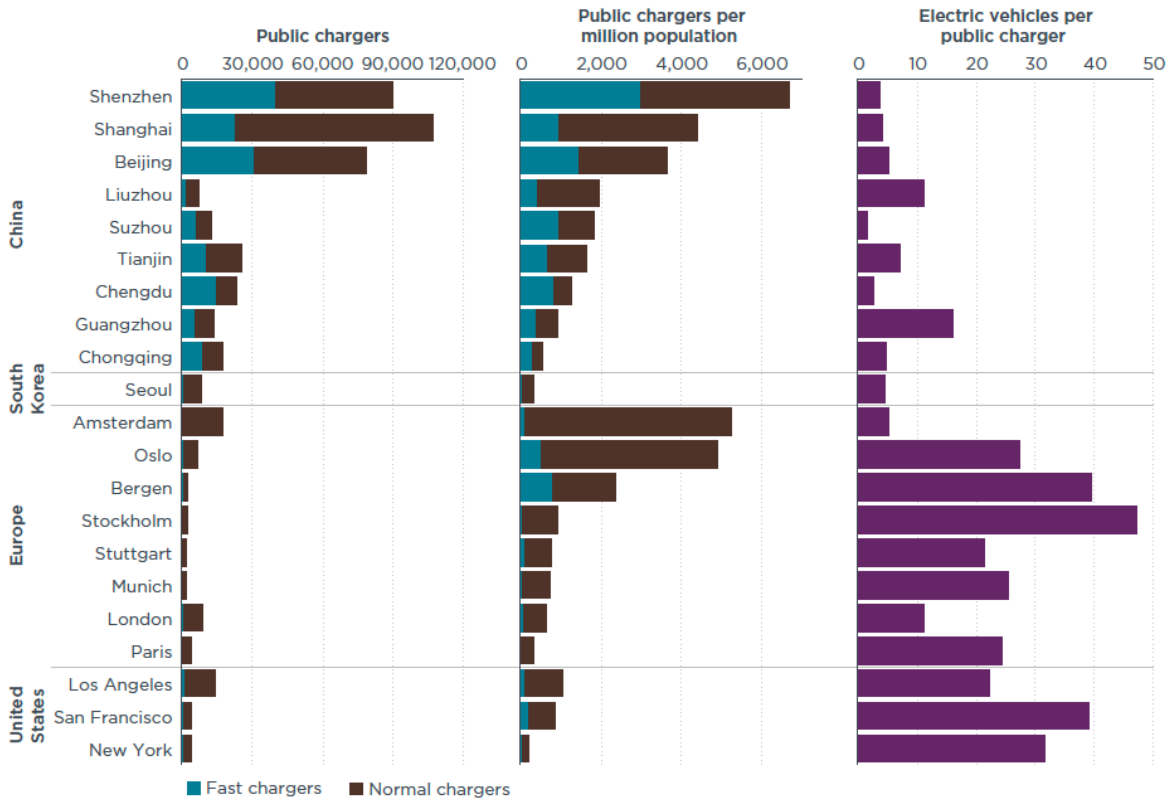

Figure 2: Regular and fast public charging infrastructure statistics in leading cities through 2020

Figure 2 shows that there is no “one-size-fits-all” solution for the amount and type of chargers needed. The local charging ecosystem depends on factors such as EV owners’ housing types, vehicle mix (BEV vs PHEV), land availability, driving patterns, and city strategies. For example, in Seoul, Amsterdam, and most

Chinese cities, most EV drivers do not have access to private parking and thus rely heavily on public charging, resulting in some of the lowest EV per charger ratios.

Within different regions of the world, the metropolitan areas with the highest 2020 EV share of registrations also tend to have the highest public chargers per million population. This shows that EV uptake increases in parallel with high charging infrastructure deployment. For example, in Europe, Bergen and Oslo had the two highest shares of EV registrations in 2020 and ranked 2nd and 3rd in public chargers per million population. Similarly, in China, Shenzhen and Shanghai rank 1st and 2nd in terms of public chargers per million population and 2nd and 3rd in terms of 2020 share of EV registrations, after Liuzhou.

4 Promotional policies and actions

This research compiled the diverse policies in these cities which have helped to push electric vehicles into the mainstream market. Table 1 provides a list of impactful policies implemented along with examples of how they have been implemented in some of the leading electric vehicle cities.

Table 1: Highlighted electric vehicle promotional policies in leading cities

Policy area	Selected city	Policy description
Planned zero-emission zone	Amsterdam and Shenzhen	• Amsterdam introduced a low-emission zone in 2009 first only affecting trucks in the city center and has been tightening ever since with the goal of having a city-wide zero-emission zone affecting all vehicles starting in 2030. • Shenzhen was one of the first cities globally to introduce a zero-emission freight/delivery zone also known as "green logistics zone" in 2018.
Private fleets electrification goals	Paris, Beijing, and Haikou	• Paris has reached 100% BEV free-floating car-sharing and 65% of its round-trip fleet is already electric. • By the end of 2021, all new taxis in Beijing had to be electric. • By 2030, all new private cars in Haikou must be electric.
Public fleets electrification goals	Bergen and San Francisco	• As a result of partnership between the public transport authority Skyss and the private transportation company Keolis, Bergen launched its 100% fossil-free bus fleet in December 2020. • San Francisco has passed a zero-emission municipal fleet ordinance stating that all light-duty passenger vehicles in the city fleets must be zero-emission by December 2022.
Demand-driven charging infrastructure deployment strategy	Seoul, London, and New York	• Seoul citizens and business owners can call or fill out and send a form to request a charging station at a specific location. • London citizens without access to off-street parking can contact their borough to ask for an on-street charging station near their home. • New York Department of Transportation collected input from the public on where chargers should be installed and allows business owners to request the installation of an EV charger outside their business.
Consumer awareness programs	Liuzhou and Paris	• Liuzhou organized a free EV test drive campaign and engaged with its citizens through a survey to understand what the most successful incentives and policies could be to spur EV uptake.

	• Paris contributed to an online platform “I drive on electricity” (“Je roule en électrique”) to answer EV-related questions and guide EV buyers throughout the entire process (from awareness to driving and charging).

The list of policies mentioned in the table above is not exhaustive. Among other actions to support EV uptake, cities have offered purchase incentives, other types of financial incentives, and non-financial benefits. Purchase incentives have been key for all markets to spur EV uptake in the early years. National governments generally distribute vehicle purchase incentives and tax discounts. However, some cities also offer subsidies: For example, given that a high share of electric cars is purchased by companies, especially in Europe, Paris offers companies a subsidy of up to €6,000 for the purchase of a new EV which can be combined with the national subsidy.

Beyond upfront vehicle purchase incentives, cities can also improve the financial case for electric vehicle ownership by offering discounts or exemptions on parking, tolls, or congestion charges for electric vehicles. Some cities also provide free parking or tolls; however, many cities have set plans to phase out these incentives over time to improve long-term revenue and manage congestion. As an example, in Oslo, BEVs were previously allowed to enter the congestion charging zone for free but now have to pay a discounted rate (less than half) compared to gasoline and diesel vehicles, and PHEVs are charged the same as gasoline vehicles.

Cities can use non-financial incentives such as road access and registration privileges to spur EV uptake and target certain users. As with the above financial benefits, these incentives will likely need to be phased out as the EV market expands to manage congestion and not encourage increased use of vehicles in the city. For example, Oslo previously granted all EVs access to bus lanes, but in response to congestion and slower bus speeds, Oslo changed its policy in 2015 to allow only high occupancy EVs in bus lanes. As another example of adaptation, in Shanghai, the city decided to extend the free license plate benefits to EV buyers until December 2023 but decided to end the privelege for PHEVs starting in January 2023.

5 Lessons learned from the EV leading metropolitan areas

This briefing identified the top 25 leading EV markets by 2020 new registrations and provided data on electric passenger vehicle registrations, charging infrastructure, and policies in place in these metropolitan areas. While each metropolitan area has its own strategy to efficiently increase EV uptake, decrease air pollution, and mitigate climate impacts, tailored to the local context, this paper identified common practices among these leading markets, giving insights about successful practices and key policies.

As shown in Figure 3, the 25 EV leading markets represent 32% of 2020 global electric vehicle registrations, with each representing at least 0.5% of the entire global EV market. For a broader context, they represent 13% of 2020 global passenger vehicle registrations and only 4% of the world’s population. As shown, 13 metropolitan areas are in China (red), 8 in Europe (blue), 3 in the US (purple), and one in South Korea (yellow).

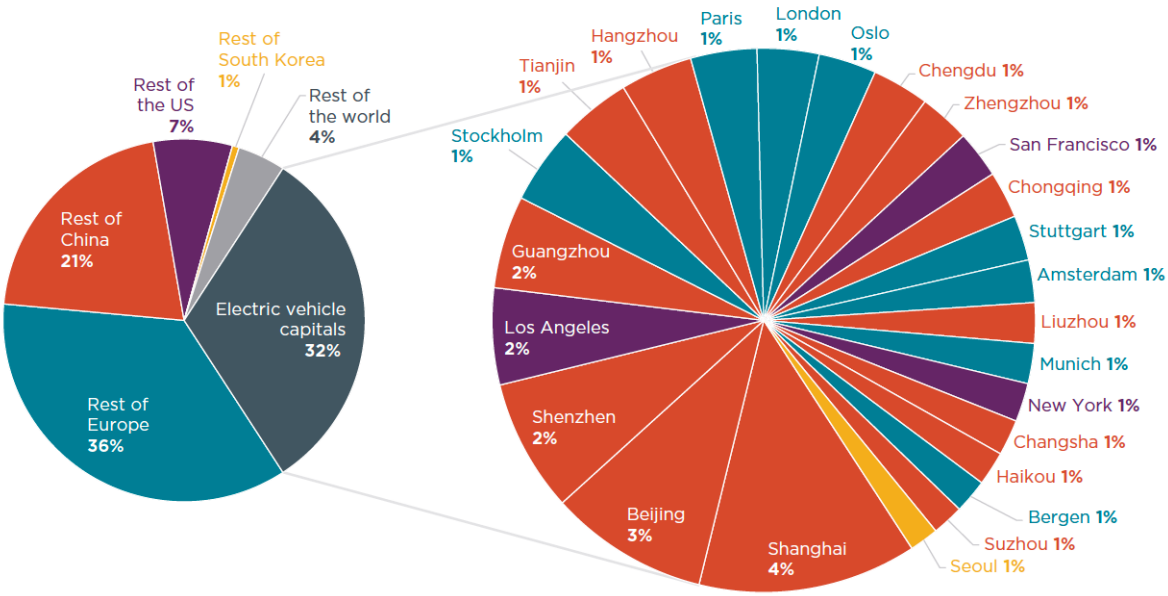

Figure 3. Share of 2020 global electric vehicle registrations in different markets with a specific focus on the 25 leading electric vehicle metropolitan areas (right)

Based on the research and the analysis previously described, we can draw high-level lessons to assist local governments in transitioning to electric mobility.

5.1 European cities led in electric vehicle registration share in 2020.

European leading cities are well ahead in EV share of registrations compared to cities in China and the U.S.A. ranging from 10.6% in Munich to 80% in Bergen. This compares to EV registrations ranging from 2.5% in New York to 29% in Liuzhou for non-European EV leading cities. However, while only 54% of European EV leading cities, electric registrations are BEVs, this share rises to a 77% average for the 17 other EV leading cities.

5.2 A comprehensive and robust charging infrastructure network is key.

While leading EV cities started by building a comprehensive charging infrastructure network providing even coverage in the entire metropolitan area, most are now at the point where a different strategy makes sense. A demand-driven strategy in which current and potential EV buyers can request or suggest a charging station location could complement a planning-oriented approach to deliver more efficient use of the infrastructure and allow the private sector to step in [6]. City EV leaders are engaging with all stakeholders and adopting charger deployment goals to ensure charging infrastructure availability does not limit electric vehicle adoption and that chargers are deployed efficiently and equitably.

5.3 A constant review and update of policy packages are important to adapt to market developments.

Cities have many tools at their disposal to spur electric vehicle uptake quickly and efficiently. As the EV market develops, some policies that were key in the early stages are being phased out, some policies are being introduced or expanded, and some would be continued but re-evaluated as the market grows. Benefits such as priority road access can slowly be rolled back, and financial subsidies can be refined to target specific groups of customers such as low-income households. Charging infrastructure deployment and consumer awareness strategies can be reassessed to meet specific needs and to include equity aspects. Zero-

emission zones (ZEZs) can be introduced or expanded in area and scope to move toward full electrification, and full electrification targets can be extended to more vehicle groups and brought forward.

5.4 An increasing number of leading EV cities are planning for zero-emission zones.

As other policies are phased out, ZEZs appear to be a promising opportunity for cities to move toward 100% ZEVs and are increasingly being announced for passenger and freight vehicles in leading EV cities. ZEZs are areas of the city where only zero-emission vehicles, such as battery electric vehicles, are granted unrestricted access. These zones can affect different categories of vehicles, from private vehicles to delivery fleets and taxis. The area usually expands over time, starting from the city center and growing to the entire metropolitan region. Zero-emission mobility also concerns public fleets, like buses, which many cities have pledged to fully electrify over different time horizons, usually up to 2030.

Acknowledgments

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References

[1] Hongyang Cui, Dale Hall, Jin Li, and Nic Lutsey, *Update on the global transition to electric vehicles through 2020*, 2020, (ICCT: Washington DC, 2021), https://theicct.org/publications/global-update-evs-transition-oct21.

[2] Dall Hall, Hongyang Cui, Marie Rajon Bernard, Shuyang Li, and Nic Lutsey, Electric vehicle capitals: Cities aim for all-electric mobility, (ICCT: Washington DC, 2021), https://theicct.org/publications/electric-vehicle-capitalsupdate-sept2020.

[3] In Europe, metropolitan areas are NUTS3 regions or a combination of NUTS3 regions which represent all agglomerations of at least 250,000 inhabitants: Eurostat. "Background - Metropolitan Regions," n.d. https://ec.europa.eu/eurostat/web/metropolitan-regions/background.
In China, EV capital boundaries are the same as city boundaries, i.e. they include the city center (also called urban area) and all districts government surrounding the city.
In the United States, metropolitan areas are defined as standardized county or equivalent-based areas having at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core, as measured by commuting ties. "Metropolitan Areas Delineation Files," Census.gov., accessed November 15, 2021, https://www.census.gov/geographies/reference-files/time-series/demo/metro-micro/delineation-files.html.
The Seoul metropolitan region encompasses the 3 provinces of Seoul, Incheon, and Gyeonggi-do, "Seoul Capital Area," in Wikipedia, September 25, 2021, https://en.wikipedia.org/w/index.php?title=Seoul_Capital_Area&oldid=1046377497.

[4] Rajon Bernard, Marie, Dale Hall, and Nic Lutsey. "Update on Electric Vehicle Uptake in European Cities." Washington, D.C.: International Council on Clean Transportation, October 8, 2021. https://theicct.org/publications/ev-uptake-eu-cities-oct21;
Anh Bui, Peter Slowik, and Nic Lutsey, Update on Electric Vehicle Adoption across U.S. Cities, (ICCT: Washington DC, 2020), https://theicct.org/publications/ev-update-uscities- aug2020; California Energy Commission, "Zero Emission Vehicle and Infrastructure Statistics," accessed in September 2021, https://www.energy.ca.gov/data-reports/energy-insights/zero-emission-vehicle-andcharger-statistics;
Automotive Data Center of China Automotive Technology and Research Center (CATARC), "Market Data China Automative Technology - 市场数据-中汽数据有限公司." http://www.catarc.info/scsj/.

[5] Bieker, G., Moll, C., Link, S., Plötz, P., & Mock, P. (2022). *More bang for the buck: A comparison of the life-cycle greenhouse gas emission benefits and incentives of plug-in hybrid and battery electric vehicles in Germany*. International Council on Clean Transportation. https://theicct.org/publication/ghg-benefits-incentives-ev-mar22/

[6] Rajon Bernard, M., & Hall, D. (2021). *Efficient planning and implementation of public chargers: Lessons learned from European cities*. International Council on Clean Transportation. https://theicct.org/publication/efficient-planning-and-implementation-of-public-chargers-lessons-learned-from-european-cities/.

Presenter Biography

Marie Rajon Bernard is an Associate Electric Vehicle Researcher at the International Council on Clean Transportation (ICCT), part of the International Partnerships team and the Coordinator of the Electric Vehicle Charging Infrastructure cluster. She joined the San Francisco office of the ICCT in 2020 as a Fellow and is now part of the Berlin office. Her work supports cities' and countries' transition to zero-emission mobility through electric vehicle adoption and charging infrastructure development. She also supports the International Zero-Emission Vehicle Alliance, a coalition of leading governments committed to accelerating the transitioning to zero-emission vehicles, by being a Secretariat member. Marie holds an Engineering diploma from ISAE-Supaero (France), and an M.S. in Energy, Civil Infrastructure, and Climate, focusing on transportation sustainability from UC Berkeley.