The Future of Urban Mobility in Smart Cities

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1. The State of Urban Mobility in Cities

More than half of the world's population—3.9 billion people—live in cities, and that number is expected to grow rapidly over the next few decades.[1] The United Nations projects that, by 2050, 6.4 billion people will live in an urban environment.[1] These concentrated hubs of economic activity, government, transportation and connectivity are beckoning, and people are gravitating toward them to find better opportunities and better lives. However, rapid urban population growth is placing overwhelming stress on the city from all sides. Just a few of the many challenges facing cities include housing, energy use, public safety, waste management and mobility. This paper focuses on the mobility challenges facing cities and how they can solve them.

Most cities did not anticipate the level of growth they're experiencing and aren't designed to support the demands of today and tomorrow. Cities must evolve, as they've always done, to become smarter, leading with digital and technological innovations and using data to achieve smart city goals such as improving economic development, quality of life and sustainability. And mobility is a critical component to achieving these goals.

$300 billion

is the estimated cost of congestion to the U.S. economy in 2016.[12]

Cities worldwide must make mobility a top priority. The mobility demands of today are straining the aging infrastructure, causing congestion that results in wasted fuel, increased noise and air pollution and loss of valuable time—all resulting in an increase in the cost of living and doing business. Mobility is central to urban life. People use trains, buses, bicycles and cars to commute to work. Cars, buses and public transit options take children to school. Waste management trucks collect and dispose of garbage. Workplaces, restaurants, retail stores and other businesses receive truck deliveries of goods and services. In a city, there are always pedestrians, bicycles, cars, trucks and buses on the road.

Mobility systems are the lifeblood of cities, and the livelihood of cities hinges on transforming the current state of mobility. Cities that rise to meet the challenge of mobility will reap the benefits of attracting and retaining more residents, which will spur growth of businesses, create more jobs and keep the city thriving.

2. Urban Mobility Will Be Smart and Clean

Mobility systems of the future must be clean, shared, autonomous and multimodal, and these systems will dramatically change how people get around in cities. The Internet of Things (IoT) will connect every resident, car, bus, mobile phone, street light, public transit system and traffic system in the smart city. Cities can build on this connectivity to develop creative solutions that will optimize commute times and traffic flows and enable coordination of alerts and responses across all platforms, devices and people. Taking advantage of new technologies will make transportation cleaner, faster, more affordable and more accessible, especially to the elderly, people with disabilities and low-income groups.

Smart: Shared, Autonomous and Multimodal (SAM)

In order to be successful, smart cities will need mobility solutions that are shared, autonomous and multimodal. Here's how each of these elements will play a role in the smart city.

On average, Los Angeles commuters wasted **100 hours** in traffic in 2016.[12]

Shared: Cars are both over- and underutilized as a resource. On average, personal vehicles are driven for a little more than an hour per day, making for about five percent utilization, and there is a near one-to-one ratio of people to cars.[2] Although used for a small percentage of time, many cars are used primarily for commuting during rush hour, creating traffic that pollutes the air, wastes time and fuel and stresses drivers: traffic congestion wasted more than 3 billion gallons of fuel and cost drivers nearly 7 billion hours in 2015 alone.[3] Technologies such as real-time information, two-way communication, scheduling and mobile transactions are fueling new business models such as on-demand ride-hailing like Uber and Lyft, operator car sharing like ZipCar, peer-to-peer car sharing like Getaround and peer-to-peer carpooling like BlaBlaCar. These companies and others are seeing increasing competition from major automakers who already have or plan to develop their own car sharing programs. A range of car sharing options will increase vehicle utilization and decrease private vehicle ownership, reducing the number of cars on streets, vehicle miles traveled and greenhouse gas emissions.[4]

There were **40,200** motor-vehicle fatalities in the U.S. in 2016 and **4.6 million** people who needed medical intervention.[13]

Autonomous: With software behind the wheel, self-driving cars will dramatically lower the cost of doing business, turn drivers into riders and free up time for other activities. Self-driving cars will be much safer, potentially reducing the 93% of traffic accidents caused by human error.[5] Autonomy will go beyond passenger cars and include buses, delivery vans and trucks, taxis and garbage trucks. Autonomous cars will park themselves, cut labor costs across multiple industries, lower the cost per mile traveled and improve the already booming car sharing business. As a result, vehicle utilization will increase while ownership and number of cars on the road will decrease. A recent survey of residents of 20 major cities around the world by the World Economic Forum showed that the majority of people expect that autonomous vehicles will be electric or hybrid.[6] It just makes sense to people.

93% of traffic crashes are caused by human error.[5]

Multimodal: Not all residents are alike, and the same can be said for their transportation needs. Bikes, buses, trains, taxis and ridesharing are all needed to get people from point A to point B. Multimodal transportation threads together different modes of transportation for residents based on their preferences for transit type, price and trip duration. Seamless multimodal transportation will help people on the move solve the first and last mile of each trip and lead to more variety in personal transport options for individuals.

95% of energy used for transportation comes from petroleum-based fuels.[8]

Clean: Electrification of Transportation (EoT)

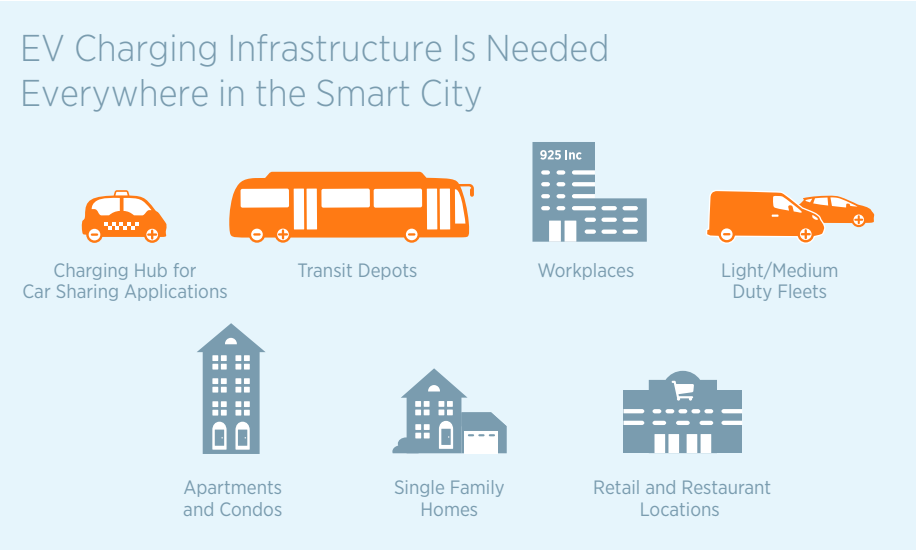
Transportation is responsible for 29% of greenhouse gas emissions,[7] and 95% of energy used for transportation comes from petroleum-based fuels, gasoline and diesel.[8] The World Health Organization estimated that in 2014, seven million premature deaths were attributable to air pollution.[9] The ongoing electrification of transportation, from passenger cars to buses and trucks, will significantly reduce greenhouse gas emissions and noise pollution in cities. EVs are also the only mode of transportation with fueling technology (electricity) that is efficient, scalable, affordable, sustainable and—most importantly—already available in cities from electric utilities.

3. Smart Charging Infrastructure Will Be Essential

Achieving smart and clean mobility requires cities to have infrastructure that is also smart. Parking spots with embedded sensors can provide real-time information about parking availability. Street lights with sensors and cameras can detect traffic congestion, measure pollution emissions and remotely turn off and on or dim LED lights, saving energy and lowering costs. Smart charging for EVs is an integral piece of smart infrastructure that will be critical to achieving cleaner, more efficient mobility in the cities of the future.

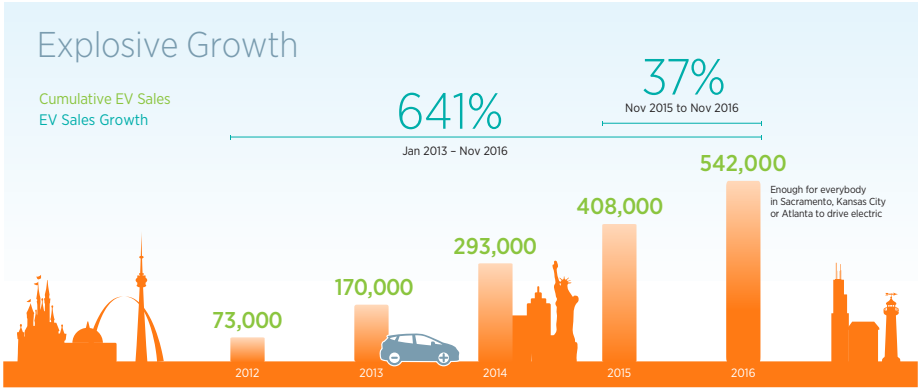
Smart EV charging connects and communicates with all the stakeholders in a smart city: vehicles, drivers, residents, parking/charging operators, electric utilities, city systems, data management platforms, payment platforms and enforcement systems and even other IoT sensors around cities. Here are just a few of the goals that smart cities can achieve with smart charging:

+ Plan infrastructure using data
+ Scale to meet growing demand well into the future
+ Save money and improve efficiency with intelligent power management
+ Connect vehicles to homes and the grid
+ Respond in real time for a better charging experience
+ Improve decisions with location awareness
+ Influence charging behavior with flexible pricing
+ Streamline planning with integrated data insights
+ Encourage electrification with smart infrastructure
+ Help low-income communities by lowering costs and improving access



Plan Infrastructure Using Data

Analyzing station usage data by location can help cities identify charging patterns, anticipate EV charging demand and develop plans for infrastructure investments. Real-time maps of EV charging stations throughout cities, coupled with utilization metrics, reveal driving and charging patterns to highlight areas that are under- or over-served so EV charging infrastructure can be planned accordingly. Data-driven infrastructure planning can also be applied at the business level. For instance, more charging stations can be installed to attract more customers to stay longer and spend more in retail areas where stations are heavily used.



Scale to Meet Growing Demand Well into the Future

EV sales have grown by 641% since 2013[10] and are forecast to reach 41 million by 2040.[11] Cities will need to scale charging infrastructure to match the growth of EVs on the road. The technology decisions and investments that cities and businesses make today must be future-proof to last the next ten years or more. The software on smart EV charging stations can be updated automatically and on an ongoing basis to provide new benefits, comply with new policies and stay connected to drivers, utilities, data platforms and other smart devices.

Transportation is the second-largest expenditure ($9,503 per year, on average) for U.S. households across all income groups.[14]

Save Money and Improve Efficiency with Intelligent Power Management

EV growth in cities will significantly increase demand on the electrical grid, requiring careful management to avoid exceeding supply. Smart charging stations capable of communicating with the smart grid, building management systems, network operators and station owners can dynamically manage the power used for EV charging. Scheduling charging to begin at off-peak hours or delaying charging until solar energy is available are just two of the many ways that smart charging can lower operating costs and help balance the load on the grid. Additional power management capabilities, such as setting a power ceiling for EV charging, can help businesses avoid incurring demand charges while dynamically distributing the available power to vehicles that are plugged in. Power management can also drastically cut down installation and operating costs, bringing smart charging solutions to more places.

Connect Vehicles to Homes and the Grid

In addition to intelligent power management for charging itself, there are several pilot programs operating that allow the energy stored in an EV's battery to flow back to the owner's home or apartment, or even to the electrical grid, supplementing supply. This provides another level of flexibility in the smart city to manage power demands at peak times. It's too early to know how these vehicle-to-home (V2H) and vehicle-to-grid (V2G) technologies will evolve, but smart charging will be key to enabling this new form of power management and determining how it helps individual EV owners and the overall grid.

Respond in Real Time for a Better Charging Experience

Drivers, station managers and cities need to know in real time whether stations are available, in use or require service. Station operating status must be proactively monitored so managers can identify problems and quickly resolve them. Real-time information also opens up a suite of solutions to potential charging problems. For example, if a driver pulls up to a charging station that is currently in use, she can use a mobile app to reserve her spot and receive a notification when the station is available. This helps stations stay in use as much as possible and charge more EVs.

Improve Decisions with Location Awareness

Residents can reduce congestion, optimize charging station utilization and help plan future EV infrastructure by volunteering to share select data. For example, residents can share their location and charging behavior data to get real-time notifications and customized charging and commute recommendations based on their travel plans and routines. Cities can utilize anonymized location and charging behavior data to identify underserved communities and expand the availability of charging there. Real-time monitoring can also deliver data that enables cities to more quickly and intelligently respond to emergencies, community events and other major activities in the city.

Influence Charging Behavior with Flexible Pricing

Demand on the grid changes throughout the day and electricity rates can change accordingly. Smart charging allows cities and station operators to manage demand by setting dynamic pricing policies to encourage desired driver behaviors. Pricing that reflects demand for electricity helps encourage charging behavior that eases load on the grid, such as charging during off-peak times. Cars that need to charge during peak times can always have their needs met while shifting the bulk of charging to reduce grid stress. Dynamic pricing can also encourage people to move their cars when they are finished charging so that others can use the stations. Smart pricing policies can even learn from driver behavior and adapt to it with prices that maximize both station availability and charging efficiency.

28% of all the energy that people in the U.S. consume goes to transporting people and goods.[12]

Streamline Planning with Integrated Data Insights

Integrating EV charging data with data from other sources, including street lights, traffic lights, traffic data and parking data, can provide a comprehensive view into how cities move. Combining and analyzing this data can yield valuable insights into problem areas as well as measure the performance of smart city transportation and energy initiatives. For example, a city can integrate EV charging data into its traffic management platform to reduce congestion by sending drivers and EVs on the best route to available charging stations. A utility can integrate charging data into its management platform to get visibility into charging behaviors and demand for electricity and carry out a predictive impact assessment for managing EV growth and demand on the grid, both at home and in public places.

Encourage Electrification with Smart Infrastructure

Electrifying transportation within a city requires developing the EV charging infrastructure to support electrification. Stations should be distributed throughout the city, and individual businesses and residents can do their part to install stations or encourage installation in certain locations. Retail stores can put in stations to attract customers who drive EVs, workplaces can install stations for employees who park there during the day and apartments and condos can install stations for residents who park overnight—and that's just the beginning. The availability of charging everywhere will encourage more people to choose electric transportation options. The potential for smart charging to not only enable the electrification of transit, but also accelerate the transformation of cities to smart cities, cannot be overlooked.

Help Low-Income Communities by Lowering Costs and Improving Access

People who own cars or have easy access to affordable public transit can reliably and conveniently get to work, school, stores, medical appointments and other obligations. But for many low-income groups, the convenience of a car or public transit is out of reach for financial or logistical reasons. How can cities ensure that all residents can get to where they need to go? EV battery cost has dropped 80% in six years[15] while the cost of fueling and maintenance is lower for EVs than for gas-powered vehicles. The total cost of owning an EV continues to decline, making EVs more attractive to low-income groups. But low-income groups can't take advantage of EVs until charging infrastructure is available and accessible in their communities. Charging infrastructure in low-income communities can serve both personal vehicles and public transit, enabling buses and shuttles to extend their routes while keeping fueling costs low and passing the savings onto residents with lower fares.

In order to measure the number of people served, reduce emissions in the community and track costs, charging infrastructure has to be smart. This will also help cities learn from data and use data insights to continue improving access and making mobility more affordable and accessible to all.

4. Charging the Future of Urban Mobility

Urban population growth is putting overwhelming stress on existing infrastructure. There is overcrowding on underfunded public transit and gridlock on roads and bridges that need repairs. Inadequate, inefficient and fossil fuel–consuming transportation systems lock cities into spending more and more money to maintain the status quo without investing in infrastructure for the future. That's why improving urban mobility through electrification must be a key component of every city's vision for the future. The right partnerships and policies can help accelerate the transition from today's disconnected, polluting cars to tomorrow's smart, clean mobility systems.

Public and Private Partnerships

Cities are eager to become smarter, but they can't do it alone. A growing number of cities throughout the world have established a smart city vision and are ready to implement smart mobility initiatives, but city budgets alone cannot fund all of the essential infrastructure for the smart city. Strong public and private partnerships are an important part of financing necessary projects and programs that are designed to produce significant and measurable improvements in mobility, sustainability, economic development and the quality of life in cities.

Policy Opportunities

Disruptive technologies in transportation and energy have the potential to transform cities, and policymakers are key to encouraging the use of these new technologies. Cities like Pittsburgh and San Francisco are testbeds for autonomous vehicles because they have crafted favorable policies. An increasing number of cities, such as Austin, Texas, are committed to electrifying transportation, spurring the need to create an entirely new fueling network to support new transit options. Policymakers have a major opportunity to take action and establish energy policies and building codes that will accelerate the implementation of smart EV charging infrastructure. Ambitious policies that support experimentation with new technologies will give cities the flexibility and motivation to discover the mobility solutions that work best for their residents.

5. Where to Start

Where should a city start? Every city faces its own unique set of infrastructure challenges, making a single cookie-cutter solution impossible. Each individual city needs to develop a plan with elements that accommodate the different needs of its residents, from electric buses to EV ready construction. Cities worldwide are experimenting with pilot programs to evaluate how new technologies can improve the lives of residents. Technology is transforming mobility even faster than most cities realize, much less are able to accommodate. Planning, organization and implementation must begin now, especially because cities are continuously changing and need to make ongoing improvements to support population growth.

Smart technology has tremendous capacity to help cities remain flexible and current and enable new transportation options to surpass their static predecessors. Investing in smart mobility solutions today is imperative to making transportation more accessible, less expensive, more convenient, sustainable and safer for years to come.

About ChargePoint

ChargePoint is the largest electric vehicle (EV) charging network in the world, with charging solutions in every category EV drivers charge—at home, at work, around town and on the road. With a network of more than 35,800 independently owned charging spots and more than 7,000 customers (businesses, cities, agencies and service providers), ChargePoint is the only charging solutions company on the market that designs, develops, and manufactures hardware and software solutions for passenger cars, electric buses and trucks for every charging scenario. Leading EV hardware makers and partners rely on the ChargePoint network to make charging station details available in mobile apps, online and in navigation systems for popular EVs. ChargePoint drivers have completed more than 25.6 million charging sessions, saving upwards of 25.2 million gallons of gasoline and driving 603 million gas free miles.

Cities are facing urban mobility challenges at unprecedented rates due to growing populations that are increasing pollution, noise, congestion and energy usage. ChargePoint brings extensive industry and technology expertise to help cities, businesses and residents achieve their urban mobility goals with:

+ A wealth of experience deploying EV charging infrastructure
+ Data and analytics to forecast future demand and plan accordingly
+ Business case insights for workplaces, apartments and condos, fleets and other organizations that contribute to improving urban mobility
+ Deep knowledge of what it takes to provide a seamless, user-friendly driver and station operator experience
+ Scalable cloud services that can be used to integrate EV charging, vehicle and other mobility data onto city, traffic and utility management platforms for greater operational efficiencies and lower costs

For more information, visit chargepoint.com.

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For More Information

Visit chargepoint.com

Call +1.408.705.1992

Email sales@chargepoint.com

ChargePoint, Inc.
240 East Hacienda Avenue
Campbell, CA 95008-6617 USA

+1.408.841.4500 or
+1.877.370.3802 US and Canada toll-free

chargepoint.com