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IN SUSTAINABILITY

How NYC Can Develop & Sustain the Largest Municipal Fleet of EVs by 2025

A Scenario Analysis and Case Study Examination of EV Adoption & Implementation

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About the Report

Research indicates that global, national, and local dynamics shape Electric Vehicle (EV) adoption and that there is a link between the adoption of EVs by consumers, generally, and EV adoption by municipalities. This means that New York City's (NYC) effort to build the largest municipal fleet of EVs by 2025 under the City's Clean Fleet Plan will continue to be shaped by external influences. As such, this report contextualizes EV adoption trends and strategies from cities around the globe within a scenario analysis that is driven by the role of three key factors supporting EV implementation. The key factors include (1) Federal and State Investment (i.e., federal and state fiscal incentives including subsidies and rebates), (2) Private-Sector Support (i.e., the extent to which consumer demand causes the private sector to continue investments in EV technology and infrastructure), and (3) Utility Leadership (i.e., the role the local utility takes as demonstrated by investments in EV infrastructure/programs with or without the city).

The goal of the report is to support NYC Fleet, and the city, as a whole, in its efforts to assess the broader landscape of EV adoption, and also to offer a starting point from which NYC can strategically support the adoption of EVs as a result of the Clean Fleet Plan in the near- and long-term. Hence, while many of the recommendations may be adoptable by the NYC Fleet team directly, some may require other governmental and nongovernmental actors.

About the Authors

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Disclaimer

The following report was written over a nine-month period from August 2016 to May 2017. Due to the continuous advantages taking place in the EV market, changes may have occurred while in the process of writing this report (e.g. policy updates, tax incentives, quantitative metrics).

About the Bard MBA in Sustainability

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EXECUTIVE SUMMARY

With the December 2015 announcement that NYC would launch an effort to develop the largest municipal fleet of EVs by 2025 through the adoption of 2,000 additional EVs into its fleet, came several calls to action for city agencies, the NYC EV taskforce, and DCAS.[1] Collectively, these entities were instructed to take the operational and planning measures necessary to position the city fleet for increased EV adoption, including assessments of fleet operations, barriers to adoption & implementation, and key collaborators & networks that may support the city's EV adoption efforts (e.g., parking lot and garage owners, car manufacturers, EV charging companies, Con Edison, etc.).[2]

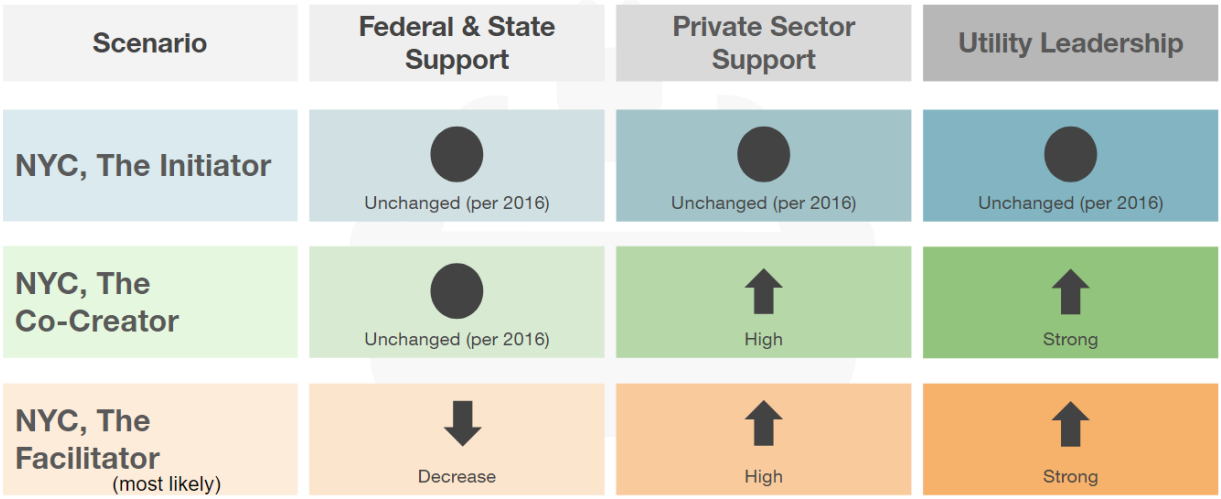
More broadly, the effort to accelerate the adoption of EVs into the NYC Fleet occurs at a relatively unique moment. For instance, in the same year that NYC announced the Clean Fleet Plan, nations around the globe announced a commitment to take proactive steps to address climate change, including a global pact to convert 20 percent of all road transport vehicles globally to EVs by 2030.[3] Additionally, the interplay between technological advancements and policy incentives have made EVs more capable of meeting consumer needs and more economically attractive. This has led to record-level EV sales. Still, in the U.S., changing political and economic dynamics means that the pace of EV adoption, in terms of sales, public support, and implementation, remains all but certain. Hence, EV adoption efforts made by municipalities, which, thus far, have relied heavily on state and federal resources, will likely be more resilient if municipalities are cognizant of the conditions that shape their local context and are prepared to implement EV adoption strategies that have proven effective by their counterparts facing varied levels of support for EV adoption locally.

This report considers the broader dynamics of EV adoption and considers what steps NYC might take to respond to those dynamics within a scenario analysis driven by influence of three key factors including (1) Federal and State Investment (i.e., federal and state fiscal incentives including subsidies and rebates), (2) Private-Sector Support (i.e., the extent to which consumer demand causes the private sector to continue investments in EV technology and infrastructure), and (3) Utility Leadership (i.e., the role the local utility takes as demonstrated by investments in EV infrastructure/programs with or without the city). Respectively, varying degrees of influence are assigned to these factors in three scenarios developed in consideration for findings from the current EV landscape as well as reports of how support for EVs may change in coming years (see table below). Accordingly, recommendations for NYC's EV

[1] "NYC Clean Fleet," City of New York, accessed May 6, 2017, http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf
[2] "NYC Clean Fleet" City of New York, accessed May 6, 2017, http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf
[3] "The Paris Agreement," United Nations Framework Convention on Climate Change, accessed May 6, 2017, http://unfccc.int/paris_agreement/items/9485.php; see also "Paris Declaration on Electro-Mobility and Climate Change & Call to Action," United Nations Framework Convention on Climate Change accessed May 6, 2017, http://newsroom.unfccc.int/media/521376/paris-electro-mobility-declaration.pdf

adoption strategies are informed by case studies fitting each scenario.

Potential Scenarios Shaping NYC's EV Adoption Efforts



Given findings from the current EV landscape, the report concludes that NYC's effort to reduce barriers to EV implementation will greatly depend on the investments taken by private-sector stakeholders (i.e., local businesses, vehicle and Electric Vehicle Supply Equipment (EVSE) charging manufacturers, landlords, etc.) and the leadership of NYC's energy utility, Con Edison. Thus, the steps that NYC takes to facilitate the EV adoption efforts by these parties could prove vital to the creation of EV and EVSE infrastructure that will support NYC's interests in developing the largest municipal fleet of EVs. Accordingly, case studies are provided which illustrate how municipalities across the country have supported their EV adoption efforts under similar conditions.

KEY FINDINGS FROM THE GLOBAL EV LANDSCAPE

- As the world transitions into the twenty-first century, technological advancements and government incentives have helped car manufacturers catalyze increased consumer demand for EVs into significant sales. Further, these mechanisms have provided governments with a strategic tool to lead in the effort to reduce carbon emissions in the transportation sector.
    - The adoption of Lithium-Ion (Li-ion) batteries as a source of power for Battery EVs (BEVs) and the subsequent progress made to enhance Li-ion battery capacity has accelerated EV manufacturing, powered EV sales, and underscored EVSE needs.

    - The cost of EV batteries has dropped faster than anticipated; nearing a price threshold that researchers believe will expand EV adoption beyond niche consumers.

    - Around the world, national incentives to reduce the price advantage maintained by gas-powered vehicles have helped to lift EV sales.

    - Within the United States, state incentives have helped consumers and localities extend the positive impact of national investment.

- EV adoption has been an all-hands-on-deck effort with national and local governments, as well as private-sector stakeholders working in concert to support implementation. Additionally, cities that have led EV adoption efforts taken steps to ensure that roles and responsibilities regarding EV and EVSE rollout are clear

    - Overwhelmingly, local EV adoption efforts by cities around the globe have been reinforced by considerable support from national governments.

    - To grow their EV fleets and build out local charging infrastructure, cities have collaborated extensively with private-sector partners and stakeholders with significant influence over the local and regional energy infrastructure resources.

    - Several cities with EV targets have created fleet procurement guidelines to prioritize EV purchasing for new and replacement fleet vehicles.

RECOMMENDATIONS FROM KEY FINDINGS

- Establish the support personnel and programmatic infrastructure to consistently monitor technological developments in the EV industry, particularly with respect to battery costs and design.

- Encourage all NYC Departments to become members of Empire Clean Cities

- Establish clear EV prioritization and purchasing schema to be followed by NYC agencies for the appropriate new and replaced fleet vehicles with guidelines on expedited permitting procedures for EVs.

RECOMMENDATIONS FROM THE MOST LIKELY SCENARIO: NYC, THE FACILITATOR[4]

- Analyze the examples of utility leadership in EV adoption, such as the program by Kansas City Power and Light (KCP&L) with Con Edison.

- Consider expedited permitting processes and collaboration with the Department of Transportation to fast-track approval of EVSE installation.

- Facilitate expanded investment by Con Edison and the private sector through the development and centralization of beneficial research and other resources.

BACKGROUND AND INTRODUCTION

1. Taking the Lead: Building the Largest Municipal Fleet of EVs of Any City in the United States (U.S.) by 2025

In December 2015, Mayor Bill de Blasio announced, "NYC Clean Fleet," a plan to improve the sustainability of the City's fleet by increasing the adoption of alternative fuel vehicles by NYC agencies.[5] Part of the administration's "OneNYC" plan which aims to reduce NYC greenhouse gas (GHG) emissions to 80 percent of 2005 levels by 2050 (80x50), "NYC Clean Fleet" offered a snapshot of the City's more than 29,000 vehicles and identified the general strategies NYC agencies could take to reduce or limit the adoption of vehicles powered by conventional energy sources (i.e., "internal combustion engine" (ICE) or "fossil-fuel powered" vehicles).[6] Overwhelmingly, the adoption of EVs to meet City needs for new vehicles, or to replace existing vehicles, was core to the City's Clean Fleet strategy. In fact, the City's goal to build the largest municipal fleet of EVs in the U.S. by 2025 underscored the announcement of the NYC Clean Fleet plan.[7]

To achieve the goal of developing the largest fleet of municipal vehicles, the following activities were identified within the NYC Clean Fleet plan:

[4] Since the conditions in Scenario C are the most likely, Scenario C recommendations are provided here for emphasis. A full analysis of all scenarios including case study overviews can be found in the body of the report.
[5] "NYC Clean Fleet" City of New York, accessed May 6, 2017, http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf
[6] At the time the Clean Fleet Plan was announced, 60 percent of the City's vehicle fleet were fueled in some capacity by alternative fuels. See: NYC Clean Fleet" City of New York, accessed May 6, 2017, http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf
[7] NYC's fleet had 323 EVs when the Clean Fleet plan was published. Recently the city reported a total of 625 EVs with an expected 375 to be added by July 2017. See: "NYC Fleet Newsletter," NYC Department of Citywide Administrative Services, April 20, 2017, accessed April 23, 2017, http://www.nyc.gov/html/dcas/downloads/pdf/fleet/NYC_Fleet_Newsletter_179_April_20_2017_Mayor_de_Blasio_Announces_Fleet_Approaching_1000_EVs.pdf

- City agencies would start to phase in EVs to meet light-duty vehicle needs where operationally and economically feasible, to achieve a target of 2,000 additional EVs into the fleet by 2025.
- An EV taskforce comprised of representatives from several central agency departments would begin to chart plans for each agency based on current vehicle replacement cycles and operational requirements. Additionally, the taskforce would work to identify infrastructure siting barriers and opportunities, and track the implementation of Local Law 130 of 2013, which requires new parking garages to be capable of supporting EVSE for at least 20 percent of parking spaces (EV Ready).
- DCAS would work with various manufacturers to update and modify existing contracts for EVs and charging infrastructure, as well as networking.

2. The Broader Context: National, Global Policy Efforts to Address GHG Emissions Foster the Environment for Local EV Adoption

NYC's effort to add 2,000 EVs to the city's fleet by 2025 operates within a broader national and global sustainability movement that both coincides with and, as discussed below, very much fuels the technological advancements that have caused EVs to surpass significant adoption thresholds. For example, in addition to NYC's 80x50 target, New York State adopted a comprehensive plan to reduce GHG emissions to 40 percent of 1990 levels in 2015, addressing GHG emissions from various sectors of the state's economy including power generation, industry, buildings, and transportation.[8] Further, at the federal level, the Clean Power Plan, announced in August of 2015, addressed carbon emissions from U.S. power plants, setting a reduction target of 30 percent below 2005 levels.[9] While many local concerns influenced their development, each of these plans were also formulated in anticipation of the United Nation's 2015 Climate Change Conference (COP 21), where 197 nations agreed to take steps to address factors contributing to global climate change, with a specific call to convert 20 percent of all road transport vehicles globally to EVs by 2030.[10] Last year, the countries with the largest EV markets declared their effort to increase the share of EVs in their government fleets, with the U.S. committing to acquire 20 percent of all new passenger vehicles as EVs by 2020 and 50

[8] "New York State Energy Plan," State of New York. accessed April 1, 2017, https://static1.squarespace.com/static/576aad8437c5810820465107/t/5797fc6ff5e231d942a2d880/1469578352695/2015-overview.pdf
[9] "Overview of The Clean Power Plan," The U.S. Environmental Protection Agency, accessed April 25, 2017, https://www.epa.gov/sites/production/files/2015-08/documents/fs-cpp-overview.pdf
[10] "The Paris Agreement," United Nations Framework Convention on Climate Change, accessed May 6, 2017, http://unfccc.int/paris_agreement/items/9485.php; see also "Paris Declaration on Electro-Mobility and Climate Change & Call to Action," United Nations Framework Convention on Climate Change accessed May 6, 2017, http://newsroom.unfccc.int/media/521376/paris-electro-mobility-declaration.pdf

percent by 2025.[11] Each of these targets build on decades-old efforts to manage air quality standards around the globe.[12]

Yet, while programs implemented to meet air quality standards have supported the adoption of alternative fuel vehicles, the relatively recent adoption of OneNYC, New York State's Energy Plan, the Clean Power Plan, and the COP 21 agreements limits the extent to which these plans directly contributed to EV adoption trends over the last decade.[13] Still, their respective development reflects a political and economic environment of urgency with respect to the need to address climate change. Furthermore, these commitments suggest the potential availability of public and private financial resources. Indeed, historically, public resources have played a significant role in EV adoption in the U.S. For instance, the Washington Post observed that the Congressional Budget Office estimated the U.S. was on a pace to subsidize EV adoption, including charging infrastructure, at a cost of more than $7.5 billion from 2012 through 2019.[14]

3. Potential Strategies Amid Transition & Uncertainty: Considering Potential EV Implementation Strategies to Sustain Momentum Toward Near- and Short-Term Goals.

As can be seen in much of the research that drives this report, global, national, and local dynamics shape EV adoption. Furthermore, there is a link between the adoption of EVs by consumers, generally, and EV adoption by municipalities. Accordingly, the report contextualizes EV adoption trends and strategies from around the globe within a scenario analysis that is driven by the role of three key factors supporting EV implementation. The key factors include (1) Federal and State Investment (i.e., federal and state fiscal incentives including subsidies and rebates), (2) Private-Sector Support (i.e., the extent to which consumer demand causes the private sector to continue investments in EV technology and infrastructure), and (3) Utility Leadership (i.e., the role the local utility takes as demonstrated by investments in EV infrastructure/programs with or without the city).

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[11] "Government Fleet Declaration," Clean Energy Ministerial, accessed May 6, 2017, http://www.iea.org/media/topics/transport/EVI_Government_Fleet_Declaration.pdf

[12] The World Health Organization's has made routine updates to guidance on the air pollutant thresholds with the repeated calls for a shift toward clean modes of transport and low-emissions vehicles. The European Union has routinely set "Euro Emission Standards" to regulate transport emissions. Further, through the Clean Air Act, the U.S. has regulated vehicle emissions while creating incentives for alternative fuel vehicles. See: "Ambient (Outdoor) Air Quality and Health Fact Sheet," World Health Organization," accessed April 15, 2017, http://www.who.int/mediacentre/factsheets/fs313/en/; "Transport Emissions" European Commission," accessed April 15, 2017, http://ec.europa.eu/environment/air/transport/road.htm; and "Regulatory Information by Topic: Air," U.S. Environmental Protection Agency, accessed April 15, 2017, https://www.epa.gov/regulatory-information-topic/regulatory-information-topic-air#transport

[13] Though the current administration recently issued an executive order reflecting its intent to dismantle the Clean Power Plan, we include it here to underscore the environment in which NYC announced its Clean Fleet Plan. See: Tatiana Schlossberg, "What to Know About Trump's Order to Dismantle the Clean Power Plan," *New York Times*, March 27, 2017, accessed May 1, 2017, https://www.nytimes.com/2017/03/27/science/what-to-know-about-trumps-order-to-dismantle-the-clean-power-plan.html

[14] Charles Lane, "The Government has spent a lot on electric cars but was it worth it?" *The Washington Post*, January 6, 2016, accessed April 15, 2017, https://www.washingtonpost.com/opinions/government-has-spent-a-lot-on-electric-cars-but-was-it-worth-it/2016/01/06/359bd25c-b496-11e5-9388-466021d971de_story.html?utm_term=.d93e786ec04b

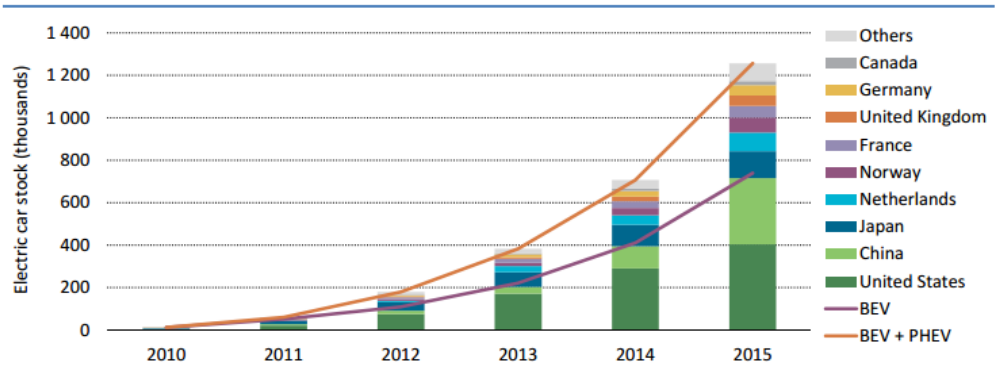
KEY FINDINGS

1. THE GLOBAL EV LANDSCAPE

As the world transitions into the twenty-first century, technological advancements and government incentives have helped car manufacturers catalyze increased consumer demand for EVs into significant sales. Further, these mechanisms have provided governments with a strategic tool to lead in the effort to reduce carbon emissions in the transportation sector.

Historically, efforts to stimulate widespread EV adoption experienced several false starts, even when global interest in EVs surfaced and resurfaced throughout the twentieth century.[15] Despite R&D programs in the United States, Europe, and Asia, EVs remained economically prohibitive and politically unpopular through the early 2000s as conventional, gas-powered vehicles maintained a strong, seemingly impenetrable hold on the transportation sector.[16] However, over the last decade, as technological advancements have reduced challenges to building demand for EVs and government policies have incentivized the purchase of EVs in the interest of environmental goals, EV sales have accelerated.[17] In fact, since 2010, global EV sales have increased from just a few thousand to several hundred thousand annually, bringing the total number of EVs on the road to nearly 1.2 million in 2015.[18]

EV Sales Between 2010-2015 (in thousands)



Source: "Global EV Outlook 2016 Beyond One Million Electric Cars," Clean Energy Ministerial et al., accessed December 15, 2016, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

[15] "A Brief History of EVs," International Energy Agency, accessed March 1, 2017, http://www.iea.org/topics/transport/subtopics/electricvehiclesinitiative/EVI_GEO_2013_Timeline.pdf
[16] "A Brief History of EVs," International Energy Agency, accessed March 1, 2017, http://www.iea.org/topics/transport/subtopics/electricvehiclesinitiative/EVI_GEO_2013_Timeline.pdf
[17] "Global EV Outlook 2016 Beyond One Million Electric Cars", Clean Energy Ministerial, et al., accessed December 15, 2016, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf
[18] "Global EV Outlook 2016 Beyond One Million Electric Cars," Clean Energy Ministerial et al., accessed December 15, 2016, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

The sale of 777,497 EVs in 2016 led to major milestone for global EV adoption efforts--more than two million EVs were on the road by the end of the year.[19] 2016 proved to be the most successful year yet for EV adoption.

2016 Global EV Sales Highlights

- An estimated 351,861 EV sales (46% of total global sales) were registered in China.
- EV sales of nearly 160,000 (21% of total global sales) were nearly 38% higher than 2015 sales and were four times the 2012 sales
- In Norway, the European leader for EV sales, EVs totaled 40% of the country's newly registered vehicles
- Canadian EV sales were up 56% from 2015, and above 100% more than 2014 sales

Sources:
Jose Pontes, "China Electric Car Sales Demolish US & European Car Sales, *Clean Technica*, January 25, 2017 accessed March 24, 2017,https://cleantechnica.com/2017/01/25/china-electric-car-sales-demolish-us-european-sales/
Robert Rapier, "U.S. EV Sale Soared In 2016," *Forbes*, February 5, 2017, accessed March 24, 2017 https://www.forbes.com/sites/rrapier/2017/02/05/u-s-electric-vehicle-sales-soared-in-2016/#702971b217f1
Paul Hockenos, "Power to the EV: Norway Spearheads Europe's EV Surge," *The Guardian*, February 7, 2017, accessed March 24, 2017, https://www.theguardian.com/environment/2017/feb/07/power-to-the-ev-norway-spearheads-europes-electric-vehicle-surge
Matthew Stevens, "EV Sales in Canada: 2016 Final Update," *Fleet Carma*, February 8, 2017, accessed March 24, 2017 *http://www.fleetcarma.com/ev-sales-canada-2016-final/*

1.1 EV Technological Advancements: Lithium-Ion Battery Adoption & Cost

The adoption of Li-ion batteries as a source of power for BEVs and the subsequent progress made to enhance Li-ion battery capacity has accelerated EV manufacturing, powered EV sales, and underscored EVSE needs.

Prior to the 1990s, car manufacturers relied on a mix of complex battery technologies to power EVs without making much headway in improving battery capacity and lifecycle.[20] In terms of sales, this stifled the ability of EVs to gain any significant traction against gas-powered vehicles, as consumers remained wary that EVs could fit their travel needs, a concern commonly referred to as range anxiety.[21] However, a switch to Li-ion batteries in the early 1990s was consequential for the EV industry, as Li-ion batteries came with several advantages,

[19] Damien Carrington, "Electric Cars Set to Pass 2M Landmark Globally by End of 2016," *The Guardian*, October 13, 2016, accessed March 4, 2017, https://www.theguardian.com/environment/2016/oct/13/electric-car-sales-set-to-pass-2m-landmark-globally-by-end-of-2016
[20] Eric Van den Steen, "Tesla Motors," Harvard Business School Case 714-413, August 2013. (Revised December 2015).
[21] Eric Van den Steen, "Tesla Motors," Harvard Business School Case 714-413, August 2013. (Revised December 2015).

most significantly, an increase in the amount of times a battery could be recharged.[22] Still, while batteries remain the most expensive aspect of manufacturing an EV, over time engineers have successfully grown battery capacity without making dramatic changes to the battery's physical makeup and installation. Many of these changes have occurred as a result of the significant amount of public resources that have been invested in R&D focused on alternative fuels.[23] For instance, the engineers of the 2016 Chevrolet Volt decreased the number of Li-ion cells used within its T-shaped battery pack, but increased the actual energy capacity of the battery, meaning the Volt now travels further, faster.[24] Additionally, Tesla recently announced its 100 kW battery pack for its Model S, the highest capacity battery pack created by the popular EV company.[25]

The cost of EV batteries has dropped faster than anticipated; nearing a price threshold that researchers believe will expand EV adoption beyond niche consumers.

Given the advancements in Li-ion batteries and increased demand for the EVs, the cost of Li-ion batteries has consistently fallen overtime. In fact, Li-ion battery pack costs are estimated to have fallen from upwards of $1,300/kwH to less than $200/kwH over the last decade.[26] Indeed, Tesla recently reported costs of $190 per pack and Chevrolet reported costs of $145/kwH per cell.[27] Each of these developments illustrates a broader trend; the pace at which the cost of Li-ion batteries has decreased far exceeds the predictions and expectations of industry analysts. This includes the U.S. Department of Energy (U.S. DOE), which, in 2010, set a cost goal for Li-ion battery packs of $125/kwH by 2022, including the cost of battery management and cooling systems.[28]

In an article published in Nature Climate Change focused on the shrinking cost of Li-ion batteries for EVs,

"BEV sales are taking off at today's cost of US$300 per kWh, but BEVs are still a niche product among early adopters… However, if [battery] costs reach as low as US$150 per kWh this means that EVs will probably move beyond niche applications and begin to penetrate the market widely, leading to a potential paradigm shift in vehicle technology."

Source: Bjorn Nykvist and Mans Nilsson, "Rapidly Falling costs of Battery Packs for EVs," *Nature Climate Change* 5 (2015) 329-332, accessed April 8, 2017 doi: 10.1038/nclimate2564

[22] Katie Fehrenbacher, "Why Tesla's New Battery Pack is Important," *Fortune*, August 24, 2016, accessed March 4, 2017, http://fortune.com/2016/08/24/tesla-100kwh-battery-pack/
[23] Katie Fehrenbacher, "Why Tesla's New Battery Pack is Important," *Fortune*, August 24, 2016, accessed March 4, 2017, http://fortune.com/2016/08/24/tesla-100kwh-battery-pack/
[24] http://www.caranddriver.com/features/2016-chevrolet-volt-dissected-everything-you-need-to-know-feature
[25] Katie Fehrenbacher, "Why Tesla's New Battery Pack is Important," *Fortune*, August 24, 2016, accessed March 4, 2017, http://fortune.com/2016/08/24/tesla-100kwh-battery-pack/
[26] Bjorn Nykvist and Mans Nilsson, "Rapidly Falling costs of Battery Packs for EVs," Nature Climate Change 5 (2015) 329-332, doi: 10.1038/nclimate2564
[27] Steve Hanley, "Electric Vechile Battery Are Falling Faster Than Expected," *Clean Technica,* February 13, 2017, accessed April 8, 2017 https://cleantechnica.com/2017/02/13/electric
-vehicle-battery-prices-falling-faster-expected/
[28] Steve Hanley, "Electric Vechile Battery Are Falling Faster Than Expected," *Clean Technica,* February 13, 2017, accessed April 8, 2017 https://cleantechnica.com/2017/02/13/electric
-vehicle-battery-prices-falling-faster-expected/

researchers at the Stockholm Environment Institute (SEI) attributed the reduction in battery costs to two factors including the data made available by industry leaders and the growing demand for EVs which has accelerated the rate of learning around EV technology by industry engineers.[29] The researchers also predicted that once battery prices reached $150/kwH, EV sales would expand beyond a "niche" consumer market, going on to capture consumers more broadly. [30] As the price of Li-ion batteries continues to drop whilst manufacturers improve battery capacities, this suggests that the advancements that car manufacturers have achieved with respect to EV batteries is close to surpassing a threshold that could see EVs become more prolific around the globe. Incidentally, government fleets, which, according to McKinsey & Company, tend to lead consumer EV adoption, will likely be on the frontlines of that any further advancements spurring EV growth.[31]

1.2 The Role of Policy Incentives

Around the world, national incentives to reduce the price advantage maintained by gas-powered vehicles have helped to lift EV sales.

Much of the growth in EV sales around the globe can be traced to national and local policies that have incentivized manufacturers and consumers to produce and purchase EVs, respectively. Generally, the use of one-time or reoccurring rebates, tax relief, as well as special nonfinancial privileges or benefits for EV consumers (e.g., high occupancy vehicle (HOV) or bus lane access, and vehicle charging discounts) have helped to lower EV manufacturing costs and stimulate EV demand.[32] The list below provides a snapshot of the incentives in the eight national markets leading EV sales.[33]

[29] Bjorn Nykvist and Mans Nilsson, "Rapidly Falling costs of Battery Packs for EVs," Nature Climate Change 5 (2015) 329-332, accessed April 8, 2017 doi: 10.1038/nclimate2564
[30] Bjorn Nykvist and Mans Nilsson, "Rapidly Falling costs of Battery Packs for EVs," Nature Climate Change 5 (2015) 329-332, accessed April 8, 2017 doi: 10.1038/nclimate2564
[31]"Evolution: EVs in Europe: Gearing Up for a New Phase," Amsterdam Roundtable Foundation and McKinsey & Company, April 2014, accessed May 6, 2017, p. 12,
[32] Though mentioned here, nonfinancial incentives are often shaped by local contexts. Like other incentives, these nonfinancial incentives influence the overall environment of EV adoption in various localities. Still, such nonfinancial incentives typically focus on specific end-user perks realized at the point of operation of an EV. Because these perks vary greatly by locality and do not implicate fleet purchases or implementation directly, they are excluded from further consideration in this section.
[33] For additional review of global subsidies see: Xingpinng Zhang et al., "Policy Incentives for the Adoption of EVs ACross countries," *Journal of Sustainability 6 (2014) 8056-8078, accessed April 15, 2017,* doi: 10.3390/sub6118056; Uwe Tietge, et al., "Comparison of Leading EV Policy and Deployment in Europe," *The International Council on Clean Transportation,* May 2016, accessed April 14, 2017, http://www.theicct.org/sites/default/files/publications/ICCT_EVpolicies-Europe-201605.pdf; "Alternative Fuels Data Center," U.S. Department of Energy, accessed April,15, 2017 http://www.afdc.energy.gov/

Incentivizing EV Demand around the Globe

Europe[34]

- **Norway** exempts BEVs from import taxes and reduces Plug-in Hybrid EV (PHEV) import taxes by 26 percent.[35] Norway also exempts BEVs from VAT taxes, vehicle registration taxes, and reduces taxes on company cars that are BEVs. [36]

- **The Netherlands** provides consumers with significant tax reductions from the country's high vehicle taxes including registration and road taxes and the tax on private use of company cars, which all increase given the level of CO2 emissions a particular vehicle produces.[37]

- **France** provides consumers of EVs with up to $7100 in direct subsidies that vary with vehicle emissions levels.[38]

- **The United Kingdom** provides EV consumers with Plug-in Car Grants, CO2-based annual ownership taxes, and reduced taxes on the private use of company cars with low CO2 emissions.[39]

- **Germany** offers low-interest loans for company EVs and EV consumers, with up to $4,524 in rebates to help the country achieve its goal of getting 1 million EVs on the road by 2020.[40] Germany provides ten-year motor vehicle tax exemption for vehicles purchased before 2016 and a five-year exemption for EVs purchased between 2016-2020.[41]

Asia

- **China** exempts EVs from acquisition and excise taxes, saving EV consumers between $6,000 and $10,000.[42]

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[34] Countries with highest rates of EV adoption presented. For more, see "ACEA Tax Guide 2017," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/news_documents/ACEA_Tax_Guide_2017.pdf

[35] "ACEA Tax Guide 2017," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/news_documents/ACEA_Tax_Guide_2017.pdf

[36] "ACEA Tax Guide 2017," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/news_documents/ACEA_Tax_Guide_2017.pdf

[37] "ACEA Tax Guide 2016," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/publications/Electric_vehicles_overview_2016.pdf

[38] "ACEA Tax Guide 2016," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/publications/Electric_vehicles_overview_2016.pdf

[39] "ACEA Tax Guide 2017," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/news_documents/ACEA_Tax_Guide_2017.pdf

[40] Hans Nichols and Birgit Jennen, "Germany to Offer 4,000 euro Subsidy to Boost EV Sales," *Automotive News Europe,* April 27, 2017, accessed April 27, 2017, *http*://europe.autonews.com/article/20160427/ANE/160429860/germany-to-offer-4000-euro-subsidy-to-boost-ev-sales

[41] Uwe Tietge, et al., "Comparison of Leading EV Policy and Deployment in Europe," *The International Council on Clean Transportation,* May 2016, accessed April 14, 2017, http://www.theicct.org/sites/default/files/publications/ICCT_EVpolicies-Europe-201605.pdf

[42] "Global EV Outlook 2016 Beyond One Million Electric Cars", Clean Energy Ministerial, et al., accessed December 15, 2016, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

- **Japan** provided EV consumers with subsidies to cover the cost differential between conventional vehicles and EVs based on the fuel efficiency and type of vehicle.[43]

The United States (Federal)

- **The U.S.** offers consumers a tax credit of up to $7,500 depending on an EV's battery capacity and weight.[44] Additionally, a host of federal programs and incentives have supported state and local level programs in their efforts to incentivize EV adoption, including the Clean Cities and Congestion Mitigation and Air Quality (CMAQ) programs. [45]

Within the United States, state incentives have helped consumers and localities extend the positive impact of national investment.

Building on the federal government's efforts to incentivize EV adoption and to support their own emissions goals, many states have created incentives in the form of rebate programs, Zero Emission Vehicle (ZEV) parking or infrastructure privileges, and other benefits to bolster consumer purchases of EVs and the growth of EV charging infrastructure. The list below provides a brief overview of the incentives offered in the five states with the most EV sales in 2016.

- **California** offers consumers a rebate for EV purchases that varies by vehicle year and vehicle type.[46] Additionally, among other programs, California implements a "Public Fleet Pilot Project" which provides public agencies operating in the state's most vulnerable and polluted areas with a rebate of up to $15,000.[47]

- **Florida** allows local jurisdictions to offer funding to property owners to finance EVSE installation as well as a Renewable Energy and Energy Efficiency Technology Grant Matching Program that rewards municipalities for demonstration,

States with Zero Emissions mandates around the country lead 2016 EV sales

State	2016 EV Sales
California	60,412
Florida	5,043
New York	4,845
Washington	4,381
Texas	3,768

Source Sunny Trochaniak, "EV Sales in the United States: 2016 Final Updates," *Fleet Carma, January 19, 2017, accessed May 6, 2017* http://www.fleetcarma.com/ev-sales-usa-2016-final/

[43] "Eco-Car Tax Breaks and Subsidies for Vehicles," *International Energy Association*, accessed May 9, 2017, https://www.iea.org/policiesandmeasures/pams/japan/name-24924-en.php
[44] "Plug-in EV Resource Center," *Drive Clean California,* accessed May 6, 2017, https://driveclean.ca.gov/pev/Costs/Vehicles.php
[45] Note that the Alternative Fuel Infrastructure Tax Credit, which provided a tax credit of up to 30% for EV infrastructure adoption to consumers expired on December 31, 2016. See: "Alternative Fuels Data Center," U.S. Department of Energy, accessed April 19, 2017 http://www.afdc.energy.gov/laws/10513
[46] "Plug-in EV Resource Center," *Drive Clean California,* accessed May 6, 2017, https://driveclean.ca.gov/pev/Costs/Vehicles.php
[47] "Public Fleet Pilot Project," California Clean Vehicle Rebate Project, accessed May 6, 2017, https://cleanvehiclerebate.org/eng/pfp

commercialization, and R&D projects related to renewable energy and energy efficiency technologies.[48]

- **New York State** provides rebates of up to $2,000 for the purchase or lease of an EV through its Drive Clean Rebate Program, tax credits for 50 percent of the cost of alternative fueling infrastructure, up to $5,000, funding for Alternative Fuel Vehicle R&D, and emissions inspections exemptions.[49]

- **Washington** exempts alternative fuel vehicles from state motor vehicle sales and use taxes and further exempts any use of public lands for installing, maintaining, and operating EV infrastructure from leasehold excise taxes through 2019.[50]

- **Texas** provides clean fleet grants to fleet operators in the interest of removing all diesel vehicles from its roads permanently, and offers a replacement voucher program to all consumers that would cover up to $3,500 of an EV purchase.[51]

2. THEMES OF SUCCESSFUL IMPLEMENTATION

EV adoption has been an all-hands-on-deck effort with national and local governments, as well as private-sector stakeholders working in concert to support implementation. Additionally, cities that have led EV adoption efforts taken steps to ensure that roles and responsibilities regarding EV and EVSE rollout are clear

As the prior section alludes, EV adoption does not happen in a vacuum. Private individuals and organizations as well as public entities benefit from a significant amount of interplay between legislative and regulatory policy as well as a host of national, state, and local fiscal and technical resources that spur innovation and support EV adoption strategies. Of course, this is true for almost every industry, but it is particularly consequential for EV adoption, which still only represents less than one percent of the overall car market.[52] This suggests that to successfully integrate EVs into their fleets, municipalities would likely need to lean into existing relationships and forge new partnerships with their local and regional peers. Further, many municipalities have built on their announced intention to adopt EVs more by memorializing those intentions into citywide EV procurement policies which prioritize EV adoption over other vehicle types.

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[48] "Alternative Fuels Data Center," U.S. Department of Energy, accessed April,15, 2017 http://www.afdc.energy.gov/laws/6072
[49] "Alternative Fuels Data Center," U.S. Department of Energy, accessed April,15, 2017 http://www.afdc.energy.gov/laws/11180
[50] "Alternative Fuels Data Center," U.S. Department of Energy, accessed April,15, 2017 http://www.afdc.energy.gov/laws/state_summary?state=WA
[51] "Alternative Fuels Data Center," U.S. Department of Energy, accessed April,15, 2017 http://www.afdc.energy.gov/laws/6583
[52] "Global EV Outlook 2016 Beyond One Million Electric Cars", Clean Energy Ministerial, et al., accessed December 15, 2016, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

2.1 National, State, and Local Embeddedness

Overwhelmingly, local EV adoption efforts by cities around the globe have been reinforced by considerable support from national governments.

- **Netherlands.** In 2012, it was estimated that total public/private investment and tax benefits connected to Dutch EV and charging infrastructure growth amounted to nearly 100 million euros.[53] Notably, Dutch municipalities were heavily supported by national governments.[54]

- **Norway.** Norway has an average 2.4 charging stations for every 1,000 registered EVs. [55] However, in cities where EV adoption is prominent such as Oslo, Bergen, and Hordaland, there are 5.2, 5.0, and 3.5 charging stations per 1,000 vehicles, respectively.[56] Significant public funding from the national government helped develop the country's charging infrastructure, with recent funding for fast chargers coming from a publicly funded Energy enterprise. On a more local scale, national investments of more than 9 million euros led to the installation of 400 charging points between 2008 and 2011 in local Norwegian metropolitan areas[57].

- **United States.** In the U.S., cities have been the beneficiaries of several federal programs implemented by various agencies, including the Department of Energy's 24-year-old Clean Cities Program, which awarded more than $400 million to projects across the country to reduce the use of petroleum in transportation.[58] Notably, members of the Clean Cities program receive technical assistance to help fleets deploy alternative fuels and advanced vehicles.[59] Additionally, along with the American Recovery and Reinvestment Act, the Congestion Mitigation and Air Quality Improvement Program (CMAQ) implemented by the U.S. Department of Transportation has provided regional and local planning agencies across the country with the financial resources to develop EV infrastructure.[60]

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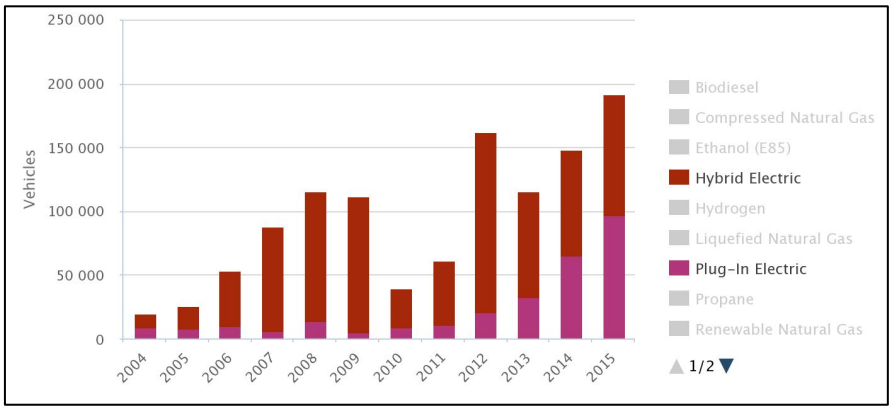
[53] "Logistics for the Implementation of the EV (LIVE)," City of Barcelona, accessed April 30, 2017, http://81.47.175.201/project-protocol/index.php/forum-22-district-heating-cooling-network-2
[54] "Logistics for the Implementation of the EV (LIVE)," City of Barcelona, accessed April 30, 2017, http://81.47.175.201/project-protocol/index.php/forum-22-district-heating-cooling-network-2
[55] "ACEA Tax Guide 2017," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/news_documents/ACEA_Tax_Guide_2017.pdf
[56] "ACEA Tax Guide 2017," European Automobile Manufacturers Association, accessed April 15, 2017 http://www.acea.be/uploads/news_documents/ACEA_Tax_Guide_2017.pdf
[57] Uwe Tietge, et al., "Comparison of Leading EV Policy and Deployment in Europe," *The International Council on Clean Transportation,* May 2016, accessed April 14, 2017, http://www.theicct.org/sites/default/files/publications/ICCT_EVpolicies-Europe-201605.pdf
[58] "Clean Cities," U.S. Department of Energy, accessed May 6, 2017, https://cleancities.energy.gov/partnerships/search?project_search=Alternative+Fuel+Vehicle+Deployment+Initiatives
[59] "Clean Cities," U.S. Department of Energy, accessed May 6, 2017, https://cleancities.energy.gov/about/
[60] "Congestion Mitigation & Air Quality Improvement Program (CMAQ), U.S. Department of Transportation, accessed May 6, 2017, https://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.pdf

- **Raleigh, NC.** Early efforts to adopt EVs and EVSE by the City of Raleigh were supported by the federal government. For instance, between 2010 and 2011, Raleigh installed 29 EV charging stations, 18 public charging stations, and 11 fleet charging stations at a cost of a little more than $300K, financed through grants from the American Recovery and Reinvestment Act and Clean Fuel Alternative Transportation program.[61]

Hybrid and Plug-In EVs Deployed by Clean Cities Members



Source: "Clean Cities," U.S. Department of Energy," accessed May 6, 2017, https://cleancities.energy.gov/accomplishments/

2.2 Private-Sector, Interagency, and Broader Network Collaboration

To grow their EV fleets and build out local charging infrastructure, cities have collaborated extensively with private-sector partners and stakeholders with significant influence over the local and regional energy infrastructure resources.

- **Barcelona City Council** created the open public-private platform Logistics for Implementation of EVs (LIVE) to facilitate the deployment and promotion of EVs.[62] Managed by the city's private sector partners, LIVE provides information about EVs to the general public and also issues EV user cards as part of a municipal network of recharging points.[63] Additionally, city collaborations with Siemens also helped facilitate conversion of larger fleet vehicles (i.e., buses and minibuses).[64]

[61] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[62] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[63] "Logistics for the Implementation of the EV", City Protocol, accessed May 6, 2017, http://81.47.175.201/project-protocol/index.php/forum-22-district-heating-cooling-network-2
[64] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf

- **Dutch** cities collaborated with private-sector partners to build out EVSE. [65] In the Netherlands, E-Laad, a consortium of electricity grid operators known as the E-laad Foundation that includes the state-owned national and regional grid operators, installed 3,000 charging stations between 2010 and 2014. When E-Laad was dissolved, public/private partnerships became of EV charging infrastructure rollout, with Dutch governments providing only 5.7 million of the 33 million euros needed to install EVSE.[66]

- **Hamburg**, **Germany** requires that 1) all charging stations sited on public land must be in line with urban layout and city architecture, 2) all EV users must be able to access any charger on public lands without an implied provider-user relationship, and 3) charging installations should focus on sourcing energy from renewable sources. [67]

- **Raleigh, NC** partnered with private entities Progress Energy Carolinas and PowerWorks Electric to design and install solar-powered charging stations as part of a two-year R&D project.[68] Raleigh also joined several other municipalities that comprise North Carolina's Research Triangle to develop the Triangle Community PEV Readiness Plan in 2012. [69] The plan identified specific roles for regional stakeholders, including electric utilities, businesses, major universities, and other regional organizations.[70]

2.3 Setting clear EV adoption guidelines

Several cities with EV targets have created fleet procurement guidelines to prioritize EV purchasing for new and replacement fleet vehicles.

- **Seattle** adopted Green Vehicle Selection Standards that established a decision-making hierarchy for the purchase of alternative fuel vehicles.[71] Seattle also identified the need for an EVSE Master Plan that identified the electrical upgrades required to support EVSE expansion.[72]

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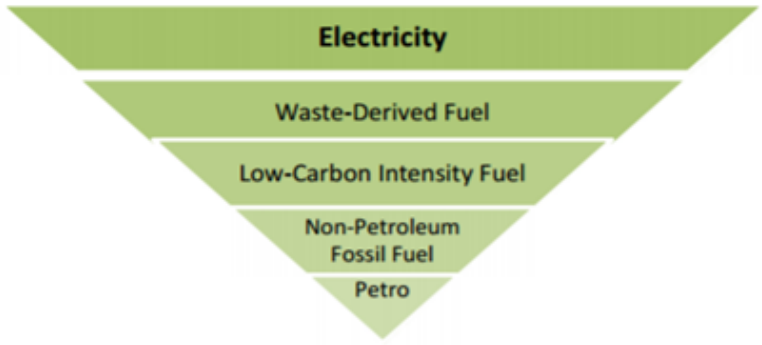
[65] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[66] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[67] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[68] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[69] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[70] Clean Energy Ministerial et al., "EV City Casebook, A look at the Global EV Movement", accessed April 15, 2017, https://www.rmi.org/Content/Files/EV_City_Casebook_2012_1.2.pdf
[71] Andrea Pratt, "A Clean and Green Fleet – An Updated Action Plan for the City of Seattle", City of Seattle Department of Finance & Administrative Services, accessed 6 May 2017, https://www.seattle.gov/Documents/Departments/FAS/FleetManagement/2014-Green-Fleet-Action-Plan.pdf
[72] Andrea Pratt, "A Clean and Green Fleet – An Updated Action Plan for the City of Seattle", City of Seattle Department of Finance & Administrative Services, accessed 6 May 2017, https://www.seattle.gov/Documents/Departments/FAS/FleetManagement/2014-Green-Fleet-Action-Plan.pdf

Seattle Alternative Fuel Vehicle Purchasing Prioritization



Andrea Pratt, "A Clean and Green Fleet – An Updated Action Plan for the City of Seattle", City of Seattle Department of Finance & Administrative Services, accessed 6 May 2017, https://www.seattle.gov/Documents/Departments/FAS/FleetManagement/2014-Green-Fleet-Action-Plan.pdf

- **Minneapolis** established a Green Fleet Policy with the goal of reducing the GHG emissions and costs resulting from current and future fleet vehicles.[73] The policy includes guidelines for measuring GHG emissions from fleet vehicles, replacing old or minimally used vehicles as needed, and educating city staff on "eco-driving."[74] A Green Fleet Team oversees the policy with representatives from various departments including Fleet Services, Environmental Services, and the Sustainability Initiative.[75]

- **San Francisco, Oakland, and San Jose** mayors follow a policy plan to expand the infrastructure required to support the use of PEVs. The Association of Bay Area Governments, Bay Area Climate Collaborative, EV Communities Alliance, and the Bay Area Air Quality Management Division created "Ready, Set, Charge California!" To provide a comprehensive guideline for EV infrastructure development. Various policy steps include the expedition of permit and installation processes, incentives for employers who install EVSE at the workplace, and purchasing programs for EVs utilized by city and state employees.[76]

[73] "City of Minneapolis Green Fleet Policy", City of Minneapolis, accessed May 6, 2017, http://www.minneapolismn.gov/www/groups/public/@council/documents/webcontent/convert_259214.pdf
[74] "City of Minneapolis Green Fleet Policy", City of Minneapolis, accessed May 6, 2017, http://www.minneapolismn.gov/www/groups/public/@council/documents/webcontent/convert_259214.pdf
[75] "City of Minneapolis Green Fleet Policy", City of Minneapolis, accessed May 6, 2017, http://www.minneapolismn.gov/www/groups/public/@council/documents/webcontent/convert_259214.pdf
[76] "Local Government Guide to EV Readiness", Association of Bay Area Governments, accessed May 6, 2017, http://www.abag.ca.gov/electric-vehicles/

RECOMMENDATIONS FROM KEY FINDINGS

- **Establish the support personnel and programmatic infrastructure to consistently monitor technological developments in the EV industry, particularly with respect to battery costs and design.** While batteries drive the costs of EVs, their development also influences the conversation around EV operations, and EVSE infrastructure. Material developments to EV battery capacity or design could dramatically influence the extent to which DCAS' current and future investments in EVSE meet the needs of its fleet. Hence, one challenge in this space is the potential for any cuts to U.S. Department of Energy grants that have supported R&D for EV batteries. Amid current uncertainties surrounding the federal budget, NYC DCAS should monitor the cost of the Li-ion batteries as well as other batteries that power EVs, particularly because new developments are expected in the industry.[77] Such developments and any corresponding costs are likely to influence the city's long-term EV infrastructure needs.

- **Establish clear EV prioritization and purchasing schema to be followed by NYC agencies for the appropriate new and replaced fleet vehicles with guidelines on expedited permitting procedures for EVs.** Several cities that have set clear goals for the adoption of EVs into their municipal fleets have created clear procurement policies that have prioritized, or at least recommended clear guidelines for, agency procurement of EVs. NYC could strengthen its existing Clean Fleet directives by creating a fleet procurement policy that prioritizes the purchase of EV vehicles.

- **Encourage all NYC Departments to become members of Empire Clean Cities.** Clean Cities is a 24-year old DOE program. With more than 100 coalitions composed of nearly 15,000 local, state, and national stakeholders, the program has much insight to offer municipalities in the way of direct assistance and resources profiling technical and nontechnical elements of EV adoption nationwide. For instance, the program's frequently updated publications page captures materials like the National Renewable Energy Lab's 2017 publication, "Regional Charging Infrastructure for Plug-In EVs: A Case Study of Massachusetts."[78] Yet, while NYC has representation in the program through Empire Clean Cities, only three City departments are members, including Parks & Recreation, Transportation, and the Department of Sanitation.[79] Participation in Empire Clean Cities from all NYC agencies, with routine reviews of resources, could help institutionalize knowledge across departments.

[77] Almost all Hybrid EVs available today utilize nickel metal hydride batteries, a longstanding technology. See: Kwo Young et. al, "Chapter 2. EV Battery Technologies"
[78] Eric Wood et al., "Regional Charging Infrastructure for Plug-In EVs: A Case Study of Massachusetts," National Renewable Energy Laboratory accessed April 20, 2017 http://www.nrel.gov/docs/fy17osti/67436.pdf
[79] "ECC Members", Empire Clean Cities, accessed May 6, 2017, http://www.empirecleancities.org/ecc-members/

SCENARIOS FOR NYC

Even as national and local fleets are integrated into broader global strategies to address climate change, fleet adoption and implementation of EVs and EVSE will continue to depend greatly on the unique conditions that exist within each national, state, and local context. For instance, consumer demand will likely frame the context within which municipal fleet adoption occurs, impacting municipal adoption efforts. However, political, economic, geographic, and infrastructure (i.e., energy & utility arrangements) dynamics will also greatly influence municipal adoption of EVs, generally, but also the extent to which municipalities are equipped with the financial resources or other tools that can help reduce barriers to EV implementation in the near- and long-term.

This section explores these dynamics further, situating them as "Key Factors" within three scenarios developed in consideration of NYC's current EV adoption and implementation landscape. The key factors include (1) Federal and State Investment (i.e., federal and state fiscal incentives including subsidies and rebates), (2) Private-Sector Support (i.e., the extent to which consumer demand causes the private sector to continue investments in EV technology and infrastructure), and (3) Utility Leadership (i.e., the role the local utility takes as demonstrated by investments in EV infrastructure/programs with or without the city). In each scenario, each of the key factors either adjusts or remains the same (status quo) and case studies are included that reflect EV implementation strategies that may support the efforts of NYC.[80]

The conditions of each scenario are presented first to set the context. Examples from other states, cities, and municipalities experiencing similar conditions were used to inform the recommended actions for NYC. The chart below provides a general layout of the scenarios. However, each scenario is further defined in the following pages.

Potential Scenarios Shaping NYC's EV Adoption Efforts

Scenario	Federal & State Support	Private Sector Support	Utility Leadership
NYC, The Initiator	● Unchanged (per 2016)	● Unchanged (per 2016)	● Unchanged (per 2016)
NYC, The Co-Creator	● Unchanged (per 2016)	↑ High	↑ Strong
NYC, The Facilitator (most likely)	↓ Decrease	↑ High	↑ Strong

[80] A complete list of all case studies examined and identified for each Scenario can be found in the report appendix.

SCENARIO A: NYC, THE INITIATOR

CONDITIONS

- Notwithstanding the current federal Administration, NYC does not experience any significant changes regarding Federal support.
- New York State makes no large changes to its current level of support and funding for the NYC Clean Fleet Plan.
- NYC's utility, Con Edison, does not actively participate in the efforts of NYC and DCAS or show interest beyond its current level of support. Con Edison remains comfortable with being a member of the EV Task Force and as the regional retail provider of electricity.
- The private sector operates independently, without a significant increase in the deployment of capital into the EV market to support EVSE infrastructure in NYC.

CASE STUDY HIGHLIGHTS

A key policy tool utilized is that of market-based instruments (MBIs).[81] Often, MBIs increase the cost of greenhouse gas intensive modes of transportation and lower the relative cost of alternative modes of transportation. In Paris, France, the cost of parking was increased and the supply of on-street and curbside parking was reduced. The areas that were previously used for on-street/curbside parking were then designated for alternative modes of transportation, including EV stations as part of the Autolib system.[82] Between 2003 and 2007, Paris reduced the on-street parking supply by 9 percent and converted 95 percent of the free parking spaces to paid parking, all combining to a decrease in traffic within the city of 11 percent.

London, England enacted a central city congestion charge in 2003. Once vehicles enter this congestion zone, they must pay a fee and emergency vehicles, public transport, taxis, and high-efficiency vehicles are excluded from this charge.[83] London realized a 21 percent reduction in overall traffic after the first year of this program and a net profit of 137 million euros in 2006.[84] In 2008, London created a Low Emissions Zone (LEV) for the city, which sets pollution standards for vehicles within the zone, and applies fines to those vehicles not meeting the standards. Various boroughs within the Greater London area have enacted similar programs related to parking fees, with increased rates during peak hours as well as for higher CO2

[81] Stephanie Cairns and Pomme Arros, "Policy Bundles for Reducing Transportation Emissions in Large Cities", Sustainability Prosperity, accessed May 6, 2017, http://www.sustainableprosperity.ca/sites/default/files/publications/files/TransportationBundles%20Oct%202014.pdf
[82] "Autolib Paris", Autolib, accessed May 6, 2017, https://www.autolib.eu/en/
[83] "Congestion Charge", Transport for London, accessed May 6, 2017, https://tfl.gov.uk/modes/driving/congestion-charge
[84] Stephanie Cairns and Pomme Arros, "Policy Bundles for Reducing Transportation Emissions in Large Cities", Sustainability Prosperity, accessed May 6, 2017, http://www.sustainableprosperity.ca/sites/default/files/publications/files/TransportationBundles%20Oct%202014.pdf

emitting vehicles. In Raleigh, NC, vehicles illegally parked in an EV designated space received a citation and fine of $50.[85] Approximately, 540 tickets were issued in 2014, generating $27,000 in revenue for the city.

Market-based instruments are powerful tools that can be implemented with the municipality's authority and can lead to behavior changes among automobile drivers. When MBIs are utilized in ways to incentivize individuals owning gas-powered vehicles to drive less due to increased fines, as well as provide positive incentives to owners of EVs, they can result in the increased adoption of EVs, as well as provide revenue to the city to direct towards further expansion efforts.

Within NYC, bridge and tunnel tolls have long been in use, but there has not been a great use of these MBIs to reduce congestions and emissions specifically. A road pricing MBI was attempted in 2007 as a major component of PlanNYC, and gained widespread support before being defeated by the State Legislature.[86] Park Smart NYC is another program within the City that has not been utilized to assist in the NYC's EV expansion efforts. With the Department of Transportation conducting pilot projects in NYC neighborhoods, Park Smart NYC would increase the parking meter rate during peak hours when demand is higher. This program could significantly help NYC's larger emission reductions goals, as a study of five UK cities found that a double of parking fees led to a drop-in car use of 20 percent.[87]

RECOMMENDATIONS

- **Utilize its policy authority to implement various market-based instruments that have shown to be successful in other cities.** Although road pricing was not originally successful in NYC, if attempted again, the appropriate parties could leverage successful case studies around the world that have shown a decrease in driving, an increase in hybrid or EV usage, and a supply of revenue to direct towards further expansion of EVs. Here, incentivizing EV adoption with all available MBIs is likely to yield the most success. One existing strategy that could be built upon is Park Smart NYC, which could be expanded to focus on EV-only parking and provide incentives for reduced costs related to parking and driving for owners of EVs, similar to policies in Paris, London, and Raleigh.

- **Aside from NYC's policy authority, it is also important to keep Con Edison involved in the City's efforts.** In a situation where Con Edison does not take leadership to increase investments in EVSE, NYC is likely still going to need to rely on strong collaboration with the utility, to remain informed of, and participate in decisions regarding EV charging rate plans, monthly service charges, and grid

[85] Ayre, James, "City of Raleigh made $27,000 Last Year Via Tickets For Cars Parked In A Single EV Charging Spot", Clean Technica, accessed May 6, 2017, https://cleantechnica.com/2014/12/30/city-raleigh-made-27000-last-year-via-tickets-cars-parked-one-ev-charging-spot/

[86] Bruce Schaller, "NYC's Congestion Pricing Experience and Implications for Road Pricing Acceptance in the United States", accessed May 6, 2017, http://www.nyc.gov/html/dot/downloads/pdf/schaller_paper_2010trb.pdf

[87] Stephanie Cairns and Pomme Arros, "Policy Bundles for Reducing Transportation Emissions in Large Cities", Sustainability Prosperity, accessed May 6, 2017, http://www.sustainableprosperity.ca/sites/default/files/publications/files/TransportationBundles%20Oct%202014.pdf

related developments impacting the city's charging infrastructure. Within this scenario, Con Edison may work with the City to develop successful rate plans and integrate EVSE with grid capabilities.[88] Due to the possibility of infrequent use within this scenario, Con Edison may not implement a demand charge, but would impose a monthly service charge and time-varying energy charge and the owner of the charging equipment would set the price for the charging service. Con Edison may control the EVSE to best integrate charging loads with the grid capabilities and needs but the infrastructure still remains privately owned.

SCENARIO SUMMARY

NYC has numerous policy levers at its disposal to support the efforts of the Clean Fleet Plan. Regardless of the steps taken, there will always be a proportion of the public who supports the City's efforts and those who oppose it. Introducing increased market-based instruments is a tool that may be most useful during a period where both Federal and State support for EVs and renewable energy, both through funding and general strategic support, is high, depending on one another to garner the support from their constituencies to prove successful.

SCENARIO B: NYC, THE CO-CREATOR

CONDITIONS

- Federal and State support remains unchanged, at current "status quo" levels.
- Investment by the private sector is relatively high.
- Con Edison is participating at a highly collaborative level with NYC and the Department of Citywide Administrative Services, specifically. Con Edison actively participates in the effort to accomplish the NYC Clean Fleet Plan. Collective support exists as Con Edison recognizes the opportunity to increase their own revenues while decreasing overall costs to their customers. They actively collaborate with DCAS and NYC on the Clean Fleet Plan, in conjunction with their own private investment citywide.

CASE STUDIES HIGHLIGHTS

Berkeley, CA has been a strong leader in the expansion of the EV market. The city's Residential Curbside EV Charging Pilot provided support to residents lacking off-street parking in order to provide a means to charging their EVs at home.[89] Although this requires collaboration and support from the local government (i.e., Department of Transportation), the

[88] Garrett Fitzgerald, et al., "EVs as Distributed Energy Resources", Electricity Innovation Lab Rocky Mountain Institute, accessed May 6, 2017, https://www.rmi.org/wp-content/uploads/2017/04/RMI_Electric_Vehicles_as_DERs_Final_V2.pdf
[89] "Residential Curbside EV Charging Pilot", the City of Berkeley, accessed May 6, 2017, http://www.cityofberkeley.info/EVcurbside/

funding was provided through a grant from the 11th Hour Project of the Schmidt Family Foundation. Individuals could apply on a first-come first-served basis to receive up to a $2,000 reduction in permit fees for the installation of EVSE. The purchase and installation of the equipment was the responsibility of the applicant, providing a successful way to increase the quantity of EVSE throughout the City without having to fully fund the infrastructure. Within this pilot program, the space immediately adjacent to the charging stations remained available to all vehicles, an important caveat in order to maintain public support.[90]

The California Public Utility Commission (CPUC) approved proposals by Southern California Edison (SCE) and San Diego Gas & Electric (SDGE) to spend $67 million deploying 5,000 EV chargers.[91] One of the main reasons stressed by both utilities was the need to meet government targets, showcasing the collaboration between the utilities and the governments to reach specified goals. These proposals garnered support due to the utility's commitment to serve as a partner in the efforts, rather than having complete utility ownership and control over rate structure, an issue that has been continuously discussed in the conversations surrounding a utility's role in the EV and EVSE market.

The French Conglomerate, Bollore Group, established the AutoLib program in Paris, France as well as BlueIndy in Indianapolis.[92] Within Paris, the AutoLib car sharing program has maintained great succes, offering subscriptions to individuals to rent "BlueCars" throughout the city, and a package for companies to develop a single account to be shared with all employees. The BlueCars are established in clusters throughout the city, and the system is operated similar to a bike share program, where members check out an EV from any station using an access card.[93] Bollore established BlueIndy in Indianapolis, as a similar system of EV car share clusters. This specific program, however, did not prove as successful. Among other reasons, business owners argued that they were not properly consulted before parking spaces in front of their retail locations were transitioned to BlueIndy stations[94]

With Federal Support continuing to remain at levels seen in the Obama Administration, DOE's Workplace Charging Resource database is a very useful resource for efforts surrounding EV expansion and adoption. The DOE determined that as demand for EVs grows, access to EVSE is one of the latest benefits tenants may consider when choosing a leased property.[95] The Workplace Charging Resources were created to assist tenants in their efforts to gain charging infrastructure within buildings they lease. The database website provides the information to assist tenants in providing the building owner and landlord with the benefits

[90] "Residential Curbside EV Charging Pilot", the City of Berkeley, accessed May 6, 2017, http://www.cityofberkeley.info/EVcurbside/

[91] Jeff St John, "Southern California Utilities to Deploy 5,000 EV Chargers in First-Of-Their-Kind Pilots", Greentech Media, accessed May 6, 2017, https://www.greentechmedia.com/articles/read/southern-california-utilities-to-deploy-5000-ev-chargers-in-first-of-a-kind

[92] "EVs, Solutions", Bollore, Accessed May 6, 2017, http://www.bollore.com/en-us/activities/electricity-storage-and-solutions/electric-vehicles-solutions

[93] "How It Works", AutoLib Paris, Accessed May 6, 2017, https://www.autolib.eu/en/companies/howitworks-businesses/

[94] John Tuohy, "BlueIndy Stations Could be Uprooted", IndyStar, Accessed May 6, 2017, http://www.indystar.com/story/news/2016/10/07/blueindy-stations-could-uprooted-agreement-lets-city-remove-five/91731408/

[95] "Workplace Charging – Attracting Tenants Through Charged Up Facilities", Office of Energy Efficiency and Renewable Energy, Accessed May 6, 2017, https://energy.gov/eere/vehicles/workplace-charging-attracting-tenants-through-charged-facilities

available to them, installation specifications, and management needs in order to make a strong case for installation of EVSE.

A report supported by the Yale Center for Business and the Environment identified utilities as the most logical partners to finance the growth of EVSE. The business model of utilities is to build, own, and operate large-scale infrastructure to move electricity, so investment in EVSEs naturally fits.[96] Utilities have the ability to play the crucial role of deferring upfront costs, a hurdle that commonly detracts first movers from installing the necessary EVSE to support EV expansion. Pacific Gas & Electric (PG&E) is proposing a Fleet Ready Program as part of its projects proposed to the California Public Utilities Commission (CPUC). This project would work with a customer to convert a fleet of fossil-fuel medium and heavy duty (MAHD) vehicles to EVs. This fleet would include transit buses and short-haul delivery vehicles, and PG&E's program seeks funding to build "make-readies" at the fleet site. "Make Readies" would provide all the infrastructure required for installation of the charger, purchased by the customer.[97] As part of Fleet Ready, PG&E is also proposing projects aimed at the electrification of trucks and refrigeration units, as well as school buses.

RECOMMENDATIONS

- **Educate land/building owners about the financial and technical resources available to support the development of charging infrastructure that can benefit the City's EV adoption efforts.** DCAS leases many of its buildings. As such, it is important for DCAS to play a role in finding funding for the building owner. If DCAS were to invest in EVSE themselves, they would own the infrastructure, and be required to move it if the building is vacated, an additional obstacle to overcome that would likely bring increased costs. Because there is also increased investment by the private sector, DCAS should look to partner with third-party providers (i.e., Greenspot or Chargepoint), to install and maintain the EVSE, funded by the building owner, and serve in a role to actively seek funding sources for the building owners.[98]

- **Partner with third party providers such as Greenspot or Chargepoint, to establish EV car sharing stations within the City.** BlueIndy's experience in Indiana offers several takeaways, namely, that private-sector support for EV does exist and that local businesses participation in EVSE rollout is critical to the EV adoption process. While drawn from the experiences of nongovernmental entities, these takeaways provide insight that NYC can leverage to build and harness support for EV adoption by local private-sector stakeholders

[96] Marissa Galizia and Eitan Hochster, "Financing EV Markets in New York and Other States", Clean Energy Finance Forum, Accessed May 6, 2017, http://cbey.yale.edu/files/YALE-CBEY-EVSE%20PAPER_FINAL.pdf
[97] Herman K. Trabish, "How California's utilities are planning the next phase of EV adoption", Utility Dive, Accessed May 6, 2017, http://www.utilitydive.com/news/how-californias-utilities-are-planning-the-next-phase-of-electric-vehicle/435493/
[98] Greenspot is a private entity that installs Chargepoint infrastructure in urban areas and is discussed in greater detail within Scenario C.

- **Collaborate with Con Edison early and often to establish clear business, social, and environmental impact goals that will support mutual success in the long-term.** As the local energy utility, Con Edison would stand to benefit from increased revenue streams associated with EV charging. Given its large fleet and bargaining power, NYC should consider ways in which it can collaborate with Con Edison to reduce charging costs.

- **Continue any examinations of progress made by the investor owned utilities in California, especially PG&E's efforts towards the Fleet Ready Program.** NYC plans to focus on MAHD vehicles as part of the near-term, near to long term, and long-term phases of its Clean Fleet Plan, and should monitor the results of PG&E's pilot program to determine best practices and feasibility. NYC should begin working with Con Edison now to develop a similar pilot project request proposal.

SCENARIO SUMMARY

In this Scenario, NYC will continue to receive support from the Federal and State governments, at levels experienced during the Obama Administration, but receives additional support from the increased participation by both the private sector and Con Edison. This additional support helps to solve the ongoing "chicken or egg" issue: does DCAS invest in EVs without a substantial network of charging stations, or EVSE to support future fleets of EVs? With the support of the private sector and utility investing in EVSE, DCAS will be able to more confidently electrify its fleet, knowing that the necessary charging infrastructure exists throughout the City.

SCENARIO C: NYC, THE FACILITATOR

CONDITIONS

- Federal Government funding, incentives, and general support for EV and EVSE is reduced.
- The private sector significantly increases investments in EVs and EVSE.
- Con Edison also increases its support, benefiting the NYC Clean Fleet Plan, although indirectly. Here, Con Edison's support mimics the observations seen in the private sector. Con Edison capitalizes on an economic opportunity to increase revenue (by selling more electricity) while decreasing overall costs to their customers, and takes steps to install EVSE around NYC, independently. They may also implement EV car sharing programs at the site of EVSE, or partner with third-party private companies to implement these programs.

CASE STUDY HIGHLIGHTS

Similar to Scenario B, third party providers are active participants that work with the private sector to install and maintain EVSE. One such example is Greenspot, a private entity that installs Chargepoint infrastructure in urban areas.[99] In Jersey City, Greenspot received approval to install ten curbside chargers as part of a Franchise Ordinance and is working with GM's Maven to implement a car sharing service of Chevy Volts throughout the city.[100]

Here, we again see utilities increasing their investment in EVSEs. Utility Dive's 2016 State of the Electric Utility Report found that 52 percent of power companies are pursuing EV charging as a revenue stream.[101] In Colorado, Xcel Energy established a partnership with Nissan to offer rebates when purchasing a Nissan Leaf. Xcel customers were eligible to receive a $10,000 incentive off of suggested retail price.[102] Additionally, Xcel developed various pricing plan options for their customers owning EVs and partnered with Nissan to advertise these plans on the Nissan website in order to incentivize the purchase of an EV. [103]

One of the most successful case studies depicting increased investment by a utility, regardless of federal/state support, is that of Kansas City Power and Light (KCP&L). In January of 2015, KCP&L announced it would spend $20 million to build more than 1,000 public EV charging stations across its entire service area, which includes the city and parts of rural western Missouri and eastern Kansas.[104] At the time, there were fewer than 800 EVs for a metro-area population of over two million. This announcement marked the largest EV charging station installation by an electric utility in the United States,[105] an excellent example of the collaboration between the utility and the private sector, investing towards the expansion of the EV market independent of governmental support.

The KCP&L Clean Charge Network is conducted in partnership with Nissan Motors and ChargePoint manufactures the chargers. KCP&L established partnerships with companies throughout the service area to serve as host locations for EVSE and offer free charging for 2 years at every station. KCP&L's actions were fueled by the business case for installing EVSE, recognizing that by installing EVSE throughout the City, customers would benefit through reduced electricity costs and revenues increased through the sale of greater electricity.

The Center for Climate and Energy Solutions and the Washington State Legislature's Joint Transportation Committee's report, "Business Models for Financially Sustainable EV Charging Networks," determined that greater private investment in EVSE is necessary to

[99] "Powering Cars for a Sustainable Tomorrow", Greenspot, Accessed May 6, 2017, http://joingreenspot.com/
[100] George Cahn, "Greenspot Selects Jersey City, NJ for Curbside EV (EV) Charging Stations and EV Car Sharing Program", PRWeb, Accessed May 6, 2017, http://www.prweb.com/releases/2016/10/prweb13790321.htm
[101] "2016 State of the Electric Utility Survey", Utility Dive, Accessed May 6, 2017, https://s3.amazonaws.com/dive_assets/rlpsys/state_of_electric_utility_2016.pdf
[102] "Drive Away with an Affordable EV in Colorado", Connect - a blog by Xcel Energy, Accessed May 6, 2017, http://connect.xcelenergy.com/electric-vehicle-nissan-offer-colorado/
[103] "Drive Away with an Affordable EV in Colorado", Connect - a blog by Xcel Energy, Accessed May 6, 2017, http://connect.xcelenergy.com/electric-vehicle-nissan-offer-colorado/
[104] "KCP&L Clean Charge Network", Kansas City Power and Light, Accessed May 6, 2017, https://www.kcpl.com/about-kcpl/environmental-focus/clean-charge-network
[105] "KCP&L Clean Charge Network", Kansas City Power and Light, Accessed May 6, 2017, https://www.kcpl.com/about-kcpl/environmental-focus/clean-charge-network

increase access to publicly available chargers.[106] The report was a collaboration among various stakeholders and three potential business models were developed for private sector investment in EVSE:

1. Businesses that benefit from the sales/use of EVs could contribute funding for deployment of DC fast charging
2. Groups of local businesses could contribute annually to a funding pool that subsidizes the cost of deploying an EV charging network
3. Or, there could be a combination of the first two models

A report by the Seattle Office of Sustainability and the Environment also emphasizes the opportunities to increase EV adoption by soliciting support from private businesses and institutions in expanding access to EVSE. It recognizes that increased access to EVSE reduces the range anxiety experienced by EV drivers, or potential EV users, and suggests opportunities to overcome this through collaboration with the private sector.[107] Four strategies were identified, two of which fall under this Scenario:

1. After-hours access to private lots
2. After-hours access to institutional properties

RECOMMENDATIONS

- **Analyze the examples of utility leadership in EV adoption, such as the program by KCP&L with Con Edison.** As utilities adjust their business and operational practices in anticipation of increased EV adoption, the relationship that cities maintain with their local utilities will play an important role of the broader effort to build out reliable EV infrastructure. DCAS should consistently review efforts made by utilities across the country to understand the dynamics of utility leadership in the space, looking to efforts like that of KCP&L as opportunities to establish aligned goals with Con Edison.

- **Consider expedited permitting processes and collaboration with the Department of Transportation to fast-track approval of EVSE installation.** DCAS should do what it can to support these efforts, through expedited permitting processes, collaboration with the Department of Transportation to fast-track approval of EVSE installation, and through the provision of information resources as mentioned above.

[106] Nick Nigro and Matt Frades, "Business Models for Financially Sustainable EV Charging Networks", Center for Climate and Energy Solutions, accessed May 6, 2017, http://leg.wa.gov/JTC/Documents/Studies/EV/FinalReport_EVChargingNetworksWEB.pdf

[107] Nelson Nygaard Consulting Associates, Inc., "Removing Barriers to EV Adoption by Increasing Access to Charging Infrastructure", Seattle Office of Sustainability & Environment, accessed May 6, 2017, http://www.seattle.gov/Documents/Departments/OSE/FINAL%20REPORT_Removing%20Barriers%20to%20EV%20Adoption_TO%20POST.pdf

- **Facilitate expanded investment by Con Edison and the private sector through the development and centralization of beneficial research and other resources.** DCAS should do what it can to support these efforts, through expedited permitting processes, collaboration with the Department of Transportation to fast-track approval of EVSE installation, and through the provision of information resources as mentioned above.

SCENARIO SUMMARY

Scenario C represents the most likely situation NYC may find itself in for the next few years, with a substantial decrease in Federal support, which may limit the reach of state support as well. Still, NYC could continue to see a surge in private-sector investment as historical barriers to EV adoption have been reduced and consumer demand for EVs continues to accelerate. Additionally, like other utilities, Con Edison becomes a more active player in EV infrastructure build-out for business reasons. Hence, while not directly collaborating with the City, Con Edison could indirectly support NYCs EV adoption goals.

CONCLUSION

To support NYC's effort to develop the largest fleet of EVs by 2025, this report offers case studies of EV implementation with consideration for the broader forces that drive EV adoption, including the influence of federal and state resources, private-sector investment, and utility leadership. By treating municipal adoption and general EV adoption by other consumers as one in the same, the report integrates an underlying truth impacting NYC's short- and long-term goals around EV adoption. That is, NYC's ability to grow and sustain the largest fleet of EVs is greatly dependent upon investments in EVs and EVSE by nongovernmental parties. Further, not only is public sentiment toward EV adoption something that NYC is subject to, but it is also something that NYC will shape through effective and sustainable EV adoption strategies. Indeed, these dynamics have underscored EV adoption by municipalities around the globe. Hence, NYC can achieve and sustain the largest fleet of EVs by leaning into the role of facilitation. In doing so, the City helps its private-sector stakeholders and the utility create the infrastructure that benefits not only their interests, but the City's as well.

Appendix I – Case Studies Examined

Policy Incentives and Market-based Instruments Utilized by the Public Sector Globally

New York, NY

- Park Smart NYC[108]
    - DOT is conducting 6-month pilot projects in various neighborhoods
    - The goal of the program is to increase the number of available metered parking spaces by encouraging motorists to park no longer than necessary
        - To accomplish this, the meter rate is higher when demand for parking is greatest and decreases when it is lower
    - A study of five cities in the UK

- Market-based instruments in NYC[109]
    - Bridge and tunnel tolls have long been used in New York. However, their application to reduce emissions and congestion have been limited.
    - A major component of PlaNYC was a congestion charge, to be funded in part by a federal grant
        - Although there was support from the public and business community, it was defeated in the State Legislature, an example of poor intergovernmental coordination

- Zero Emission Vehicles Charging Infrastructure Program[110]
    - $3 million was made available in 2016, through the Environmental Protection Fund, for municipalities in New York to purchase EV's and EVSE.
    - It offers municipalities rebates of up to $8,000 for Level 2 EVSE and up to $32,000 for DC fast chargers, with rebates not to exceed $250,000 per facility. Applications were considered on a first-come, first-served basis until funding was exhausted.
    - Municipalities will be eligible to receive reimbursement of up to $5,000 per vehicle for purchase or leasing of clean vehicles, and up to $250,000 per facility for installation of EVSE.
        - A total of up to $750,000 was available for clean vehicle rebates. Municipalities that purchase a new clean vehicle on or after April 1, 2016 are eligible for the rebate. Rebates of $2,500 were available for vehicles with a 10-50 mile electric range. Rebates of $5,000 were available for vehicles with an electric range greater than 50 miles.
        - A total of up to $1,250,000 was available for Electric Vehicle Supply Equipment infrastructure. Costs incurred by a municipality to provide charging stations that offer Level 2 networked EVSE or Direct Current Fast Charging service are

[108] "Motorists & Parking, Park Smart," *New York City Department of Transportation,* accessed May 10, 2017, http://www.nyc.gov/html/dot/html/motorist/parksmart.shtml
[109] "Policy Bundles for Reducing Transportation Emissions in Large Cities," *Sustainable Prosperity*, October 2014, accessed May 10, 2017 http://www.sustainableprosperity.ca/sites/default/files/publications/files/TransportationBundles%20Oct%202014.pdf
[110] "Governor Cuomo Announces $3 Million Available to Municipalities for Zero-Emission Vehicles and Charging Infrastructure," *New York State*, September 8, 2016 accessed May 10, 2017 https://www.governor.ny.gov/news/governor-cuomo-announces-3-million-available-municipalities-zero-emission-vehicles-and-charging

eligible for rebates up to $8,000 per port or $32,000 per pedestal. A match equal to 20 percent of the rebate request was required.

Raleigh, North Carolina

- Enforcement of EV-Only Parking Spaces[111]
    - In 2012, Raleigh implemented rules pertaining to parking spaces designated for EV's
    - Illegally parked vehicles receive a citation of $50
    - In 2014, Raleigh generated $27,000 in revenue from this rule, from approximately 540 citations

Paris, France

- Market based instruments have been implemented in Paris to reduce GHG emissions[112]
    - The city has increased the cost of parking, removed minimum parking requirements for new developments within a 500-meter range of existing metro stops, and reduced the supply of on-street and curbside parking.
    - Space that was previously dedicated to on-street parking is reallocated to alternative uses such as motorcycle/scooter parking, docking stations for Velib' bike share and for the Autolib' EV car sharing service.
    - Total on-street parking supply in the city was reduced 9 percent from 2003-2007 and at the same time, 95 percent of free parking spaces were converted to paid parking.
        - These steps were first adopted in 2001 and they have been correlated with an 11 percent decline in traffic in the city

London, England

- Central City Congestion Charge[113]
    - All vehicles (except emergency vehicles, public transport, taxis, and high efficiency vehicles) pay a price to enter the zone. A camera and license plate recognition system identifies vehicles and allots payments
    - After one year, London experienced a 21 percent decrease in overall traffic, a 30 percent decline in congestion, and a 43 percent increase in cycling
        - The system generated a net profit of £137 million in 2006
    - A Low Emissions Zone (LEZ) was created in 2008, covering a majority of the city
        - Pollution standards are set for all vehicles operating in this zone, and strict financial penalties are applied on vehicles that do not meet the standards
    - Greater London Area Boroughs established differential rates for on-street parking
        - Different rates were established based on the time of day (peak vs. non-peak), the level of vehicle CO2 emissions (with higher polluting cars paying more), and free parking for electric and car share vehicles

Hamburg, Germany

- Harbor City[114]

[111] James Ayre, "City of Raleigh Made $27,000 Last Year Via Tickets For Cars Parked In A Single EV Charging Spot," *Clean Technica* December 30, 2014, accessed May 10, 2017, https://cleantechnica.com/2014/12/30/city-raleigh-made-27000-last-year-via-tickets-cars-parked-one-ev-charging-spot/

[112] "Policy Bundles for Reducing Transportation Emissions in Large Cities," *Sustainable Prosperity*, October 2014, accessed May 10, 2017 http://www.sustainableprosperity.ca/sites/default/files/publications/files/TransportationBundles%20Oct%202014.pdf

[113] "Congestion Charge," *Transport for London*, accessed May 10, 2017, https://tfl.gov.uk/modes/driving/congestion-charge

[114] "HafenCity Hamberg" *Hafencity Hamburg*, accessed May 10, 2017 http://www.hafencity.com/en/index.html

- A city-owned entity is redeveloping a cluster of disused industrial harbor islands into a standard-setting neighborhood focused on resilience, with anticipated completion in 2025
- Due to proneness to flooding, secondary elevated walkways and secured ground level doorways and windows are used
- Alternative modes of transportation, including EV's, are central to design of the city
    - A 60-page guideline document has been created for developers, architects, and engineers to address flooding risk in design and construction. It emphasizes the strategic placement of wall-mounted charging stations and ceiling-mounted cables.

Connecticut

- Department of Energy and Environmental Protection Public Fleet EV and Public Workplace Charging Incentives[115]
    - This program provided funding to municipalities and state agencies to purchase EV's or EVSE. The application deadline ended in 2016.
    - DEEP used funds from the Regional Greenhouse Gas Initiative to provide a rebate of up to $15,000 per vehicle and $10,000 per charger. Each grant recipient was limited to a maximum of 6 vehicles and 6 chargers.[116]
        - The funds could also be designated for the installation of EV charging stations for use by employees - up to $10,000 for one dual-head or two single-head charging stations was made available without the purchase of an EV.
        - Funding was also available to towns/agencies who owned a parking area where employees or the public were allowed to park for 10 hours per day or longer - up to $2,000 was available for the purchase and installation of a two-outlet Level 1 EV charging station

Berkeley, CA

- Residential Curbside Electric Vehicle Charging Pilot[117]
    - Berkeley is currently offering this pilot program to allow residents who lack off-street parking a means of charging their EV's at home
    - Along with funding from the 11th Hour Project, permit fees are reduced by up to $2,000 on a first-come, first-served basis, continuing through December 2017.
    - The parking adjacent to the charging infrastructure will remain open to all vehicles
    - Berkeley secured grant funding in order to meet the interests of the private (civilian) sector, while simultaneously increasing the amount of EVSE in the city overall
- Residential Curbside Electric Vehicle Charging Pilot[118]
    - Now concluded, this program helped to fast-track the permit process for non-residential areas.
    - It did not include any financial incentives but the Alternative Fuel Vehicle Refueling Property Credit (a Federal Tax Credit) was reinstated and made available for EV

[115] "EV Connecticut Charger Incentives" *Department of Energy & Environmental Protection*, accessed May 10, 2017 http://www.ct.gov/deep/cwp/view.asp?a=2684&q=561884&deepNav_GID=2183
[116] "Regional Greenhouse Gas Initiative," *Regional Greenhouse Gas Initiative*, accessed May 2017 http://www.rggi.org/
[117] "Residential Curbside Electric Vehicle Charging Pilot," *City of Berkeley*, accessed May 10, 2017 http://www.cityofberkeley.info/EVcurbside/
[118] "NonResidential Curbside Electric Vehicle Charging Pilot," *City of Berkeley*, accessed May 10, 2017 http://www.cityofberkeley.info/EVchargingpilot/

charging station installations through the end of 2016, providing up to $30,000 or 30 percent off the cost of EVSE and installation for businesses.

- Specifications for Electrical Vehicle Charging Readiness[119]
    - For new residential parking, at least 10 percent of spaces (or at least 1 space if less than 10 spaces total), shall be pre-wired to allow for future Level 2 EVSE installation
    - Specifications are outlined for instances where a car lift is used, stating that the pre-wiring may be part of the car lift or on the walls of the lift, "provided that future PEV charging systems could be used by vehicles on the car lift and the minimum 10 percent of parking spaces threshold is maintained."
    - Multifamily projects must have at least one of the pre-wired parking spaces be an accessible parking space
    - New non-residential with 20+ spaces must have at least 3 percent of the spaces pre-wired for future Level 2 EVSE installation

<u>Business Models for Financially Sustainable EV Charging Networks</u>

- Business Models for Financially Sustainable EV Charging Networks[120]
    - Produced recommended public sector interventions for EV adoption and expansion related to Washington State:

Intervention	Financial Performance Impact
Low-Interest Loan	Finance 50 percent of project debt (30 percent of total project capital costs) at an interest rate of 5.4 percent with a 10-year term. This rate is 33 percent lower than the assumed private sector loan interest rate of 8 percent.
Grant	Subsidize cost of charging station equipment by 50 percent.
Zero-Emission Vehicle (ZEV) Program	Increase charging station utilization growth rate from 15 percent to 30 percent.
Building Codes	Require new construction or major renovations to provide power to a fixed number of parking spots on site. For applicable sites, the effect of this intervention is estimated to subsidize 50 percent of the cost of electric utility upgrades and grid interconnection for DC fast charging sites ($10,000) and 50 percent of the cost of construction and equipment installation ($13,000 for DC fast charging sites and $2,000 for Level 2 charging sites).
Consumer Education	Develop and implement a campaign to educate consumers about EV's, including

[119] "Specification for Electrical Vehicle Charging Readiness," *City of Berkeley*, accessed May 10, 2017 http://www.cityofberkeley.info/EVChargingSpecs/

[120] Nick Nigro and Matt Frades, "Business Models for Financially Sustainable EV Charging Networks," *Center for Climate and Energy Solutions*, March 2015 accessed http://leg.wa.gov/JTC/Documents/Studies/EV/FinalReport_EVChargingNetworksWEB.pdf

	public awareness campaigns, ride-and-drives, media engagement, and employee engagement programs. The effect of this intervention is estimated to increase charging station utilization growth rate from 15% to 18 percent.
Extending (Establishing) BEV Sales Tax Exemption	Extend (or establish) a sales tax exemption for BEV's
Shared Use EV Charging Stations (Publicly Available and Public Fleets)	State or municipal public fleets considering incorporation EV's in their vehicle fleets share a privately owned and managed charging station with the general public, rather than deploy a dedicated charging station with restricted access. For applicable sites, the effect of this intervention is estimated to increase initial DC fast charging station utilization by 1 session per day and the maximum charging station utilization by 1 session per day.

Private Sector Investment in Electric Vehicles and Electric Vehicle Supply Equipment (EVSE)

Bollore Group Car Sharing Services

- Autolib - Paris, France[121]
    - Individuals become members, and receive an access card allowing them to retrieve a "blue car" from any AutoLib station
    - Provides service to individuals as well as companies, with various membership plans and rates depending on number of employees
- BlueIndy - Indianapolis, IN[122]
    - Installed EV car sharing clusters throughout the City
    - Offers numerous membership plans depending on needs, allows individuals to reserve a vehicle, and provides a guaranteed parking spot
    - Of note - this program received a great deal of negative feedback from the community, as business owners felt they were not offered the ability to provide feedback, and were not consulted before parking spaces were transferred to BlueIndy

Greenspot EV Infrastructure

- Private entity focusing on infrastructure in urban areas[123]
- Installed 10 Chargepoint charging sites in Jersey City's downtown Powerhouse Arts District in October 2016.
    - Included a total of 19 charging cables

[121] "AutoLib" *Autolib*, accessed May 10, 2017 https://moncompte.autolib.eu/account/
[122] "BlueIndy," Blue Indy," access May 10, 2017, https://www.blue-indy.com/
[123] "Revolutionizing urban mobility for a sustainable tomorrow," *Greenspot*, accessed May 10, 2017 http://joingreenspot.com/

    - Greenspot received approval to install the curbside chargers through a Franchise Ordinance
- Greenspot is currently working with GM's Maven car sharing service to implement a car share of Chevy Volts, where the cars would be deployed on city streets so individuals are not required to go to a central location for a vehicle.
- Greenspot is able to develop public-facing EVSE in collaboration with the private sector or private EVSE for Fleet-only vehicles.

FastNed Charging Network

- FastNed provides nationwide coverage throughout the Netherlands, with 58 stations nationwide.[124]
    - Builds fast-charging stations along the highway, with the goal of expanding throughout Europe.
    - Is a publicly traded company and also has a "Founders Network", providing benefits to financial supporters.
    - All stations are fast chargers and solar-powered

Workplace Charging Resources for Building Owners and Landlords

- Department of Energy Workplace Charging Resources,[125] CalStart Best Practices for Workplace Charging,[126] and a presentation from BOMA on International Workplace Charging at Leased Facilities[127]
    - As demand and use of EV's increases, access to EVSE is one of the latest benefits tenants may consider when choosing a leased property
    - These resources are available to assist in providing building owners and landlords with information on the benefits available to them from EV's and EVSE, installation specifications, management needs, tenant education, and more.
    - Municipalities could assist in locating funding for building owners/landlords to pay for cost of EVSE and installation and building owners/landlords could partner with other third-party providers (e.g. Chargepoint, Greenspot) to install and maintain EVSE

Seattle, WA

- Removing Barriers to Electric Vehicles Adoption by Increasing Access to Charging Infrastructure[128]
    - To increasing EV adoption, solicit support from private businesses and institutions in expanding access to EVSE
    - Expanding access reduces the issue of range anxiety, and opportunities to overcome this exist through collaboration with the private sector

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[124] "FastNed," *Fastned*, accessed May 10, 2017 https://fastned.nl/en/
[125] "Workplace Charging – Attracting Tenants Through Charged Up Facilities," *U.S. Department of Energy*, accessed May 10, 2017 https://energy.gov/eere/vehicles/workplace-charging-attracting-tenants-through-charged-facilities
[126] "Best Practices for Workplace Charging," *CalStart* September 2013, accessed May 10, 2017 http://www.calstart.org/Libraries/Publications/Best_Practices_for_Workplace_Charging.sflb.ashx
[127] "Sheldon Oppermann, Karen Penafiel and Paul Wessel, "Workplace Charging at Leased Facilities," *BOMA*, *November* 2015 accessed May 10, 2017 https://energy.gov/sites/prod/files/2015/11/f27/WPCC_2014summit-session2A-OPW_1114.pdf
[128] "Removing Barriers to Electric Vehicle Adoption by Increasing Access to Charging Infrastructure," *Seattle Office of Sustainability & Environment*, October 2014, accessed May 10, 2017 http://www.seattle.gov/Documents/Departments/OSE/FINAL%20REPORT_Removing%20Barriers%20to%20EV%20Adoption_TO%20POST.pdf

- Three suggested strategies:
  - After-hours access to private lots:
    - Incentivize and encourage parking lot owners and management companies to allow paid access to managed and access controlled lots, after hours for use of EVSE.
    - Develop a marketing campaign or web tool to better advertise the availability of these EVSE parking locations.
    - Encourage information and advertising opportunity for lot/garage owners/managers and for nearby residents.
    - Require conduit trenching with wire access when surface parking lots are resurfaced.
  - After-hours access to institutional properties
    - Encourage the installation of EVSE and increase access to parking lots at institutions located within neighborhoods such as churches, community centers, schools, and universities.
  - Adaptive Use of City-owned Property
    - Utilize vacant and underused City properties with electrical service for interim or extended EVSE stations.
    - Develop Public Private Partnerships (PPP) with charging network providers to manage and maintain locations.
    - Prioritize EVSE uses of City-owned surplus property.

<u>Business Models for Financially Sustainable EV Charging Networks</u>

- Business Models for Financially Sustainable EV Charging Networks[129]
  - Made recommendations for potential business models for financially-sustainable EVSE deployment:
    - Businesses that benefit from sales/use of EV's could contribute funding for deployment of DC fast charging
    - Groups of local businesses could contribute annually to a funding pool that subsidizes the cost of deploying the EV charging network
    - A combination of the first two models

Utility Leadership & Investment in Electric Vehicles and Electric Vehicle Supply Equipment (EVSE)

<u>California Public Utility Commission</u>

- Approved proposal by Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E) to spend $67 million deploying 5,000 EV chargers
  - SDG&E will enable the site hosts to select the specific charging equipment, while also testing the reactions of EV hosts and owners to time-of-use rates.
  - SCE will build all transmission and distribution infrastructure but will use third parties to build and own a station in exchange for revenue from the power sold at the charger
- Pacific Gas & Electric (PG&E) FleetReady Program
  - This pilot program is focused on electrifying Medium and Heavy Duty (MAHD) fleet vehicles including school buses, public transit, delivery fleets, and private shuttles.

[129] Nick Nigro and Matt Frades, "Business Models for Financially Sustainable EV Charging Networks," *Center for Climate and Energy Solutions*, March 2015 accessed http://leg.wa.gov/JTC/Documents/Studies/EV/FinalReport_EVChargingNetworksWEB.pdf

- $211 million has been requested for this project. It is estimated to take five years to complete and pay for the installation of EVSE infrastructure for non-light-duty vehicles.

- SDG&E Power Your Drive Program[130]
  - SDG&E will install 3,500 charging stations in apartments, condos, and businesses.
  - SDG&E owns, operates, and maintains the chargers. There is no cost to the site host as SDG&E covers all operations and maintenance costs as well
  - These stations are for private use, by the apartment/condo residents or by company employees and provides the option to bill the electricity use to the property owner or to the driver.
- Southern California Edison Charge Ready Program[131]
  - Conducting a pilot project to install 1,500 EVSE throughout its service area with an investment of $22 million
  - It is currently no longer accepting applications from partner site locations
  - Through this pilot program, SCE will install and maintain the supporting EVSE. Participants then own, operate, and maintain the charging stations
    - To incentivize non-residential partners to participate, SCE offered rebates to cover some of the costs of the charging station and installation
  - At the conclusion, SCE will request an expansion of this project to 30,000 chargers from the CPUC
  - SCE provides two rate options for businesses to charge the EV's, to ensure it makes the most sense for that business's day-to-day operations[132]

<u>Kansas City Power and Light</u>

- Clean Charge Network[133]
  - January 2015 - Kansas City Power and Light announced it would spend $20 million to build more than 1,000 public EV charging stations across its entire service area, which includes the city and parts of rural western Missouri and eastern Kansas. At the time, there were fewer than 800 electric vehicles for a metro-area population of over 2 million.
    - This announcement made KC P&L the largest electric vehicle charging station installation by an electric utility in the United States
    - After one year of this program, there were 613 charging stations installed, and 1,200 EV's in the metro area.
  - The KCP&L Clean Charge Network is conducted in partnership with Nissan Motors and the chargers are manufactured by ChargePoint. KCP&L established partnerships with companies throughout the service area to serve as host locations for the EVSE and free charging for 2 years at every station was offered.
  - Today, the Network includes over 1,000 public charging stations.
    - A charging map removes "range anxiety" according to KC P&L[134]
    - A portal for drivers which will tell the driver how many miles they have left and when/where to charge up, within the Network[135]

[130] "Power Your Drive," *Semprea Energy,* accessed May 10, 2017 https://www.sdge.com/clean-energy/electric-vehicles/poweryourdrive
[131] "Why We're Adding New EV Charging Stations in California," *Edison International*, accessed May 10, 2017 http://www.edison.com/home/our-perspective/charge-ready-a-plan-for-california.html
[132] "Electric Car Rate Options," Southern California Edison, accessed May 10, 2017 https://www.sce.com/wps/portal/home/business/electric-cars/electric-car-business-rates
[133] "KCP&L Clean Charge Network," *Clean Charge Network*, accessed May 10, 2017 http://kcpl.chargepoint.com/
[134] "Chargepoint Dashboard," *Clean Charge Network* accessed May 10, 2017, https://kcpl.chargepoint.com/charge_point

        - Charging usually occurs during non-peak hours when the electric grid is underutilized. This Network encourages individuals to use KCP&L's grid more efficiently and drive down the cost of electricity for everyone
    - By partnering with Chargepoint, KCP&L ensured customers are part of a nationwide network, and that they face consistent pricing through the city's network. Economies of scale with KCP&L's Clean Charge Network will help keep costs low. As a utility, KCP&L's costs are regulated by state commissions. These factors combine to ensure a fair price for the stations.
        - Partnering with Nissan provided the funding for 16 DC fast-charging stations, and covered the cost of the electricity to provide the 2 years of fast charging
        - Host sites are selected using a variety of criteria to ensure the Network is accessible at geographically diverse sites that are convenient for customers to access

Yale Center for Business and the Environment

- Financing Electric Vehicles Markets in New York and Other States[136]
    - Identified utilities as the most logical partner to finance the growth of EVSE
    - Investment in EVSE's naturally fits the utilities business model and utilities can play the crucial role of deferring upfront costs
    - Developed a scenario if a NY utility (e.g. Con Edison) adopted a similar model as Southern California Edison (SCE) did and covered the upfront electricity preparation while also providing a subsidy to the 3rd party that owns the charger:
        - If Level 2 chargers were used, the utility would pay $5,900 per charger. The site electricity preparation or "make ready" fee is about $2,000 plus a $3,900 subsidy per charger.
        - The site host would cover installation and any premium on the cost of the charger, which would total around $5,000.
        - Assuming the third party owned and operated the station and charged $1 per hour and $0.25 per kWh (which is equivalent to about $0.40/kWh), with a 10 percent annual usage growth rate from current levels, the NPV of the station would be 2.4 times greater for the station owner than it would be if the station owner had to make the full investment.
        - The NPV of the electricity revenue to the utility would be about $40,000, a substantial amount of revenue for a $5,900 investment.

Xcel Energy

- Excel Energy Partnership with Nissan in Colorado[137]
    - Xcel Energy customers who purchased a Nissan Leaf by March 31, 2017 were eligible to receive $10,000 off of MSRP.
    - Xcel also developed various pricing plan options for customers owning EV's, advertised on the Nissan website to incentivize the purchase of EV's

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[135] "KCP&L Clean Charge Network," *Clean Charge Network*, accessed May 10, 2017 http://kcpl.chargepoint.com/
[136] Marissa Galizia and Eitan Hochster, "Financing Electric Vehicle Markets in New York and Other States," June 5, 2015, accessed May 10, 2017, http://cbey.yale.edu/files/YALE-CBEY-EVSE%20PAPER_FINAL.pdf
[137] *Janet*, "Drive away with an affordable electric vehicle in Colorado," *Xcel Energy*, March 7, 2017, accessed May 10, 2017, http://connect.xcelenergy.com/electric-vehicle-nissan-offer-colorado/

- Helps customers save on fuel costs at approximately $1 per gasoline gallon equivalent or less
- Peak Demand Pricing Plan, Time of Use Pricing Plan, or General Residential Plan
- Xcel offers “Windsource for Electric Vehicles” to provide a low-cost, hassle-free way to receive wind energy as one’s electricity source