ISSN 2005-8349 GRI연구논총 2020년 제22권 제1호

# Comparing Electric Vehicle Delivery Strategies of Major Global Cities

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As opposed to the tendency that electric vehicle (EV) policies have been studied at the national level, this study compares those at the level of the city It particularly analyzes European and U.S. cases in order to draw implications for metropolitan areas in Korea. First, World-leading cities commonly establish step-by-step plans, particularly they are equipped with short-range plans considering rapid technological developments in battery charging and storage capacity and with a monitoring and feedback protocol for adjusting their plans and achieving ultimate goals. Second, social and spatial settings are reflected in city-level EV strategies, for example, an image as an environmental leader is used to bring about a virtuous circle for the distribution of EVs and charging infrastructure as well as for EV-related industries and research and development activities. Third, for extended electric vehicle miles of travel and drivers' reliability on EVs, a close collaboration between neighboring areas—for instance, between Seoul, Incheon, and Gyeonggi—are rather necessary not only in building the charging infrastructure and EV-friendly road systems, but also in conducting collaborative research and demonstration projects. Lastly, mobility electrification can be initiated by the mayor leadership, but it may be facilitated and managed through a taskforce or other types of cooperative systems for the realistic involvement of key stakeholders. In the same sense, as a main implication for Korean cities, whether to set the EV goal on the number/percentage of EVs or charging stations should be determined by considering stakeholders' number/size, interests, positions, relationships, resources, incentives, and timing/target years among others.

**Key words** _ Electric Vehicles, Charging Infrastructure, Transportation Policies, Comparative Analysis

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ISSN 2005-8349 GRI REVIEW Vol. 22, No. 1, February 2020

# 해외 주요도시 전기자동차 보급전략 비교분석

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과거 전기자동차 관련 정책이 국가 수준에서 연구된 데에 반해 본 연구는 도시 수준 정책의 비교분석을 시행한다. 특히 한국 대도시권에 적용 가능한 함의를 발견하기 위해 유럽과 미국의 사례를 검토한다. 분석결과로서 첫째, 세계 전기차 선도도시들은 단계식 계획을 설립하고 특히 배터리 충전 및 저장과 관련한 급속한 기술개발을 감안하여 이에 적절히 대응하기 위한 단기계획을 수립한다. 둘째, 사회적, 공간적 배경이 도시 수준 전기차 전략에 반영되어 있는데, 예를 들어 친환경 리더로서의 도시 이미지는 전기차와 충전시설, 전기차 관련 산업 및 연구개발 활동의 일련의 과정에 선순환을 발생시킬 수 있다. 셋째, 일회충전 운전거리를 늘리고 전기차에 대한 운전자 신뢰도를 높이기 위해서는 이웃한 지역(서울, 인천, 경기) 간의 밀접한 공조가 필요한데, 이는 충전소 설치와 전기차 친화형 도로시스템 건설뿐만 아니라 공동 연구 및 실증 프로젝트 개발 및 실시에도 해당한다. 마지막으로 전기차 도입은 지자체장의 리더십으로 시작되는 편이지만 이를 촉진, 활성화, 관리하기 위해서는 태스크포스 형태의 협력체를 통해 주요 이해관계자의 실질적 참여를 분명히 하여야 한다. 같은 맥락에서 한국 도시들에 대한 주요 함의는 전기차 목표를 전기차 대수로 할지 충전소 개소수로 할지에 대한 결정이 필요한데, 이때에도 이해관계자의 수/크기, 관심사, 입장, 관계, 자원, 인센티브, 타이밍/목표년도 등을 고려하는 것이 바람직하다.

**주제어** _ 전기차, 충전시설, 교통정책, 비교분석

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# I. Introduction

As small towns grew into metropolitan cities, urban trips including those by automobile became more frequent and lengthy. Accordingly, excessive energy consumption from the transportation sector exerted a substantial impact on climate change and in particular, tailpipe emission from the internal combustion engine of the automobile aggravated the air quality of the cities. Thus, in order to mitigate these problems, international cities turn to alternative fuel vehicles, particularly electric vehicles (EVs).

Indeed, owing to recent advances in EV technologies and subsequent reduction in EV purchasing costs, EVs are rapidly distributed throughout land transportation systems. IEA (2019) reported that EVs reached 5.1 million in 2018, 2 million increase from 2017. Also, new EV sales turned out to be almost doubled in one year. The EV distribution was substantially supported by national policies such as financial incentives, tax exemption/ reduction, and administrative support. These policies encourage private companies to voluntarily invest into batteries and charging facilities and transportation systems to be electrified.

However, these policies are not enough to deliver EVs at the city level and to electrify urban transportation systems. In line with the increasing number of EVs, cities are required to be equipped with sufficient charging infrastructure and smart management systems. Particularly in urban areas, the number/density and location of charging facilities may be related to parking problems and traffic congestions. In this sense, city governments are desirable to design strategies for the intelligent management of the electricity generation, storage, and transmission as well as for the timely expansion of EVs.

At this juncture, while EV studies have mostly focused on national policies, this study aims to compare strategies at the level of the city considering its unique settings. Specifically, it will analyze EV-related plans and policies in European and North American cities and draw implications for cities in Korea and other Asian countries.

# II. EV systems

## 1. Electric vehicles

EVs, which are also called plug-in electric vehicle (PEVs), are categorized into battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). BEVs are run only by electricity charged in batteries, whereas PHEVs are equipped with an auxiliary internal-combustion engine (ICE) in addition to batteries.

Meanwhile, according to the all-electric range (AER), referring to the distance to which an automobile can run only with electricity, EVs can be categorized into: (1) long-range BEVs, (2) limited-range BEVs, (3) range-extended PHEVs, and (4) minimal PHEVs (NRC, 2015).

## 2. Charging infrastructure

A successful delivery of EVs hinges on supportive charging infrastructure. The infrastructure is often analyzed in terms of the location of the charging facilities (home, workplaces, and intra-city, inter-city, and inter-state types) and charger types (AC level 1, AC level 2, DC fast charging) (NRC, 2015). The U.S. National Research Council (NRC) (2015) found that residential charging infrastructure (at home) is equipped with the highest importance in the EV success and inter-state infrastructure with the lowest. This appears because automobiles are parked longer at home than driven elsewhere. Actually, in the U.S., around 80% of the lifetime of an automobile is parked at home. Thus, locating charging stations at home or in residential neighborhoods would be the most effective way of fueling EVs.

Meanwhile, establishing charging facilities at workplaces may also be important for a higher EV adoption rate and extended eVMT (electric VMT or vehicle miles traveled). Additional benefits are to offer green images for companies and to attract and retain employees. However, if the charging demand goes beyond the maximum electricity limit, it will cause additional costs (for the update or expansion of the facilities).

## 3. Smart management systems

If EV infrastructure is focused simply on charging EVs as many as possible, the government cannot efficiently deal with issues when charging demand is concentrated on a certain short period of time, when charging facilities are broken, or when power reserves are depleted. Smart management systems can address these issues through information and communication technologies (ICTs). The systems aim to minimize the EV charging time and to maximize the efficiency of the charging facilities (Gharbaoui et al., 2012).

Aside from ICT, however, recent practices and research do not have due concerns for how to produce

electricity using environmentally friendly energy sources. EVs may run on non-renewables such as coal and nuclear power sources. In response to this, some cities (to be shown below) have installed solar energy panels on the roof of EV parking lots.

Also, to proactively address the climate change problem, several cities have established environmentally friendly energy shift policies for energy self-sufficiency and accordingly, reduced the use of fossil fuels and increased that of renewable energy. Regarding the energy shift policies, the importance of energy storage systems is highlighted. As an energy storage system, the EV battery can be a viable alternative and this potential emerges in the fields of smart grid and energy shift.

In the next section, we will discuss how global cities deal with the issues the intelligent management system as well as the delivery of the EV and charging infrastructure in their jurisdictions.

# III. EV strategies by city

## 1. Barcelona

Barcelona supports its regional EV industry to have higher competitiveness than neighboring metropolitan cities by expanding the use of the EV in the public and private sectors and updating the charging infrastructure. Specifically, the city set a short-term goal for 2024 through its "Electric Mobility Strategy 2018-2024" (Barcelona City Council, 2018) and also, currently work on the establishment of the 2030 mid-term and 2040 long-term goals.

As of 2018, Barcelona run on electricity 1,500 vehicles as the city government fleet (35% of the total), 4 buses, and 1,057 private vehicles. The city set an ambitious goal to electrify 80% of the city government fleet, to distribute 100 or more electric buses, and introduce 24,000 electric private cars. Regarding the charging infrastructure, currently 450 free charging stations are installed mostly at gas stations and parking lots. Also, various benefits are given for EV drivers; for example, 75% return of the automobile tax and free parking at designated parking lots.

Barcelona set five goals through its Electric Vehicle Master Plan (Barcelona City Council, 2016). First, the city will function not as a single model city, but as a metropolitan city along with adjacent suburban areas. Second, it will be a best practice example for other cities by leading the EV delivery procedure at the city level, not at the national

level. Third, it will establish far-reaching policies through the cooperation between various city departments and will form governance by facilitating collaborations with non-governmental institutions and private firms. Fourth, the city will ultimately reduce the use of inefficient and polluting fossil fuels in its residential areas with high population density and traffic congestion. Fifth, for energy shift, the city will incorporate electricity into basic energy sources and generate electric power regionally and through renewable ways.

As part of its Electric Vehicle Master Plan, Barcelona government intensely uses its public-private cooperation consortium, called LIVE (Logistics for the Implementation of the Electric Vehicle) (Live Barcelona, 2019). It is open to all related public and private companies and ultimately encourage citizens to purchase EVs. In particular, it helps individuals and organizations to save costs by applying to various subsidies and incentives. In addition to EV purchases, it also provides financial support for the installation of charging facilities. Besides, it assists the growth of small- and mid-sized enterprises in EV-related industries. Notably, LIVE issues EV owners a membership card. Tax incentives and free parking are allowed to the card holders and also, the card is used for charging electricity.

〈Figure 1〉 Electric charge stations in Barcelona and Catalonia
(https://livebarcelona.cat/en/charge_points/)

In Europe, Barcelona has the second highest penetration rate of motorcycles for personal mobility, following Rome. Accordingly, it has a larger number of electric motorcycles compared to other European cities. Among the above-mentioned 450 charging stations, 125 stations are specific to motorcycles and the number is planned to increase.

Barcelona administers "Chargelocator" as a platform for offering charging-related information for EV drivers. As a mobile app, it alerts what the cheapest and closest station is and how the charging and payment can be made. Also, through the reviews of previous users, EV drivers can assess the speed and accessibility of charging facilities.

## 2. Berlin

Berlin established a EV delivery plan, "Emobility," not only to vitalize local economy, but also to address the environmental, transportation, energy, and climate issues of the city by electrifying transportation modes (eMO, 2011). Emobility has an important role in linking the energy and transportation fields. As part of the plan, various research and pilot tests are implemented in Berlin and nearby Brandenburg. As such, the city attempts to reveal its national and international superiority and leadership in the EV industry.

As of mid-2018, around 6,000 EVs are run in Berlin and Brandenburg and among them, 75% are used for commercial purposes (Meissner, 2018). With regard to e-bikes (electric bikes), about 150,000 vehicles were reported to run in the two areas. Also, they have about 800 public charging stations in which 20 rapid charging 5 hydrogen facilities are included. Notably, Berlin does not aim at directly increasing the number of EVs and instead, it rather expects a natural increase by improving the services of the charging facilities.

Through Emobility, Berlin makes an effort to achieve the following goals: (1) to develop a new value in the automobile industry and in the long-term, to strengthen the existing economy and to create new industries; (2) Using benefits as a national capital, to showcase the expertise of Germany to the world; (3) to sell EVs and charging systems worldwide by facilitating new technologies and services; and (4) to reduce noise and air pollution in the city and accordingly to improve the quality of life of Berlin citizens (Berlin Senate Department for Economics, Energy and Public Enterprises, 2019).

Also, while upgrading Emobility, Berlin is running a new project to install more than 1,600 EV charging stations on the road in 2019 (Berlin Senate Department for Economics, Energy and Public Enterprises, 2019). The project is labeled "Immediate Clean Air Program (in German, Sofort Saubere Luft)" and this label reflect

the fact that the existing plan is implemented at a slower speed than have been expected. EU administration also recommend its members that they should immediate secure a sufficient number of EV charging facilities. Otherwise, the member would be fined and further, the administration may file a lawsuit. As a response, Berlin is promptly installing additional charging stations.

To achieve the above-mentioned goals of Emobility, Berlin has detailed action plans. First of all, to make potential buyers to purchase a EV, its price should be reasonable in comparison to conventional automobiles and its performance should be attractive. Also, charging facilities should be installed in an easily accessible distance so that drivers can find them when the battery is low. In the case of Berlin, EV-related technologies have reached very high levels, which positively worked on the price and performance, together. Also, administrations provide EV technology companies with various incentives that also encourage new technological developments. Moreover, more Berlin citizens are expected to buy EVs since economic incentives preferential taxes are offered for EV owners.

〈Figure 2〉 Emobility charging in Berlin
(https://www.flickr.com/photos/93015232@N04/9775645535)


Secondly, based on the competitiveness as the national capital, Berlin has favorable settings for the growth of EV industries. Existing EV-related companies transform the city in which EVs and further researched, produced, and purchased. Also, experts at major universities and research institutions in Berlin collaborate with those in nearby Brandenburg, and this will enable the electrification of transportation modes in and beyond Berlin.

Thirdly, Germany is famous for its image as the most environmentally friendly country. This social condition can be used for a marketing strategy to further strengthen the EV industry. Also, because a significant proportion of the power generation is based on renewables and this provides environmental images for charging facilities in the city.

## 3. London

To carry the promises as provided in the Paris Agreement, London Mayor planned a picture of turning all on-road transportation modes as zero-emission vehicles by 2030 (London Government, 2019). Also, he made the world-first Ultra Low Emission Zone in order to reduce fossil fuel-based automobiles and to shift them to electric or hydrogen vehicles.

As of June 2019, about 20,600 EVs are running on London roads. Regarding public transportation, London has 1,700 electric taxis and 165 electric buses; the number of the e-buses is the largest among European cities. This has been made possible by successfully installing 175 rapid charging points and the increasing number of about 1,100 charging facilities attached to streetlamp posts. Indeed, on the national scale, about 25% of the public charging facilities of the U.K. (around 2,400 stations) are located in London. London is close to top 25 capitals in which around a half of the total EVs are owned. Its rapid charging networks are known to be superior to those of New York, Madrid, Amsterdam, and other world cities.

The environmentally friendly mobility strategy of London is concerned more on how to distribute charging facilities than on increasing the number of EVs. Thus, the mayor launched in May 2018 the EV charging facility taskforce to discuss how to distribute the facilities (London Mayor's Electric Vehicle Infrastructure Taskforce, 2019). The taskforce comprises a total of 140 or more facility companies and public and private institutions. Through meetings and discussions, it aims to satisfy the various stakeholders' interests and drivers' needs in delivering the facilities.

To better deliver the charging infrastructure, London taskforce suggested a total of six key issues in three different fields. In the field of land and energy, London should address the following issues: (1) how to secure suitable locations for the charging facilities in face of its limited available land (2) how to simplify complex charging facilities whose establishment requires considerable amount of time and effort, and (3) how to reduce the cost of upgrading the energy grid. In the field of the operation and user, major issues are (4) whether the most usable (accessible) facility is really available (whether it is broken or already taken by other users) and (5) whether the driver thinks the facility to be inconvenient. Lastly, in relation to the investment aspect, investors may be readily motivated once they do not have uncertainty about which type of chargers are required and concerns on whether the facility is quickly outdated. The taskforce highlights the importance of the public sector to address all of the six issues.

The city considers several "enablers" as a key to the issues. First, it plans to establish the first rapid charging

hub in 2020 for a quick response to the electricity charging needs. Also, it will support the charger sharing businesses, make it easy to install and monitor charging facilities through a new cooperative system.

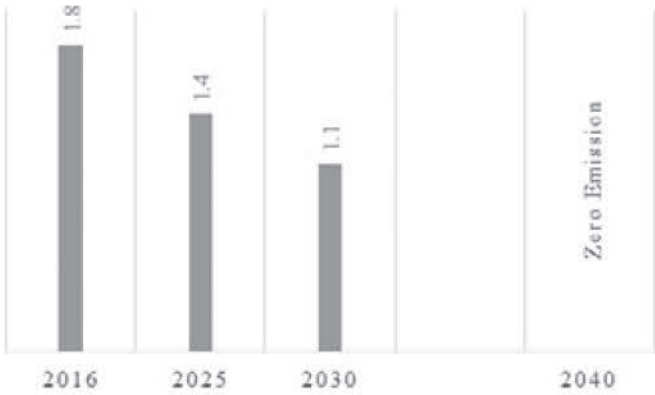
To remove the energy barrier, since June 2019, the city has confirmed the limited energy grid and used online tools to identify cheaper and more accessible charging facilities. Also, it considers alternative energy sources and/or smart power supply to eliminate the barrier.

Lastly, the city makes an effort to develop a guideline for building the EV charging system to share knowledge on the system and to maximize its potential. Furthermore, it considers specifying the protocol for the charger and EV, so the charging facilities can be smoothly distributed.

## 4. San Francisco

To reduce greenhouse gas emission of the city, San Francisco has implemented the Climate Action Plan since 2002. It aims to reduce the emission by 40% in 2025 from the reference year of 1990 and 80% in 2050 (SFMTA, 2019). Regarding the transportation system, it announced in 2017 the Transportation Sector Climate Action Strategy according to which the city plans to make 80% of all travel be sustainable (by nonmotorized modes such as public transit, walk, and bike).

〈Figure 3〉 Greenhouse gas emission reduction targets from private transportation in San Francisco (MMT CO2E: million metric tons of carbon dioxide equivalents) (SFMTA, 2019)




Also, San Francisco enacted the Healthy Air and Clean Transportation Ordinance (HACTO) in 2010 to support the expansion of the zero- and low-emission vehicles and alternative fuel infrastructure (EV charging

stations and hydrogen fuel pumps). Subsequently, it passed in 2017 two EV readiness ordinances. The first forces all city-owned minicars to be shifted to zero-emission vehicles by 2022. The second regulates at least 20% of parking spaces in all residential, commercial, and public buildings should be equipped with sufficient electricity infrastructure for EV charging.

Among the most notable EV policies of the city is San Francisco EV Roadmap, which was announced in 2019. The ultimate goal of the roadmap is to electrify all types of private mobility, and to achieve the zero emission from the transportation sector by 2040. The roadmap consists of specific strategies in a total of six dimensions: (1) improving public awareness, (2) offering various incentives, (3) expanding charging infrastructure, (4) linking to the power grid, (5) electrifying medium- and heavy-duty vehicles, and (6) electrifying mobility services (e.g., taxis and rent cars).

〈Table 1〉 Electric vehicle delivery targets of San Francisco (SFMTA, 2019)

| Types | By 2025 | By 2030 | By 2040 |
|---|---|---|---|
| Percentage of new passenger cars that will be shifted to EVs (while allowing no increase in household automobile ownership) | 50% | 100% | All starting, ending, and passing trips concerning San Francisco will have zero-emission. |
| Percentage of new vehicle miles that will be covered by EVs | 50% | 100% | |
| Number of med- and heavy-duty commercial cars that will be registered | 2,000 | 10,000 | |
| Percentage of inbound commuter cars that will be electrified | 33% | 66% | |

1) Improving public awareness

One goal of the roadmap is to encourage drivers and the public to consider EVs when they choose mobility by allowing them to recognize major EV benefits. Specific strategies include public awareness campaigns (e.g., operating online website, distributing posters and leaflets for education and communication, and providing institutional education programs), EV help desks (for information and technical supports), and EV test ride programs for the general public.

2) Offering various incentives

San Francisco EV Roadmap provides preferential price incentives for the purchase of EVs over gasoline and diesel vehicles. In addition to purchase and lease incentives, EV owners can benefit from EV-exclusive lanes, EV-preferred parking facilities and street parking spaces, and reduced travel costs (congestion fees and tolls).

### 3) Expanding charging infrastructure

The roadmap attempts to provide effective and various charging options throughout the city. In this attempt, the city studies the effectiveness of where to locate the charging infrastructure in public housing complexes and where to distribute the rapid chargers in the city. In addition, it considers the development of the smart charging program to optimize the power charging, the establishment/expansion of the charging infrastructure in city-owned parking facilities, the expansion of charging systems in parking facilities that are privately owned, but can be open to all citizens, and installation of the facilities on road curbs among others.

### 4) Linking to the power grid

The city also plans to provide incentives on the electricity charge to make EVs economic alternatives to gasoline/diesel transportation modes. Specific programs include the reasonable pricing of public and residential level 2 chargers and rapid charging stations and investment incentives for stationary batteries.

### 5) Electrifying medium– and heavy–duty vehicles

The roadmap implements demonstration projects to encourage medium- and heavy-duty vehicles to adopt EV technologies. Specifically, it supports pilot programs for delivery vans/trucks, commuter buses, and carpooling vehicles and also, considers incentives and regulations for electrifying the vehicles.

### 6) Electrifying mobility services

The roadmap also takes into consideration the electrification of mobility service vehicles. In this sense, the city would support the electrification of Uber, Lyft, and other transportation network companies (TNCs) as well as conventional taxis and pilot programs for EV sharing and rental services.

In relation to the above six dimensions and related specific strategies, the roadmap sets different goals for the years of 2025, 2030, and 2040 and highlights the monitoring of the status and subsequent feedback loop. Notably, the roadmap was specified by the participation of 15 people including representatives from city departments and agencies, regional and state governments, private and non-profit institutions, industry partners, and other stakeholders and through the input of the opinions by general citizens.

## 5. New York City

New York City provides preferential incentives for purchasing, charging, and driving EVs as follows. (1) Purchasing incentives: Through the Drive Clean Rebate, which is administered by the State of New York, EV buyers can apply to a rebate of up to 2,000 U.S. dollars. Also, at the time of the EV purchase, the federal government offers a federal tax return of a maximum of 7,500 dollars according to the size of the battery (NYC311). (2) Charging incentives: Notably, corporate utilities can apply to EV charging incentives. Recently in New York, Con Edison and Fleet Carma began to run the Smart Charge New York Program. EV owners who participate in the program can receive a 20-dollar reward per month by not charging in the peak period, particularly between two to six in the afternoon, and another 5-dollar reward per kWh by charging in the off-peak period. In addition to the rewards, the participants are given data from Fleet Carma on driving efficiency, charged/consumed energy, and battery conditions among others. Moreover, through its Clean Pass Program, the State of New York allows EV drivers to use HOV (high occupancy vehicle) lanes on Long Island Expressway (LIE) and the New York Thruway Authority gives EV drivers a 10% discount on the E-Z Pass (electronic toll charge system adopted on toll roads, bridges, and tunnels) charge.

Also, regulations are used to support the delivery of EVs. According to the Local Law 130 of 2013, all newly built privately-owned parking lots and public parking facilities should install electricity systems for EV charging in at least 20% of their parking spaces.

In addition, New York is running projects that are connected to private companies and city schools. Recently, Envision Solar installed 37 solar energy carports in the city (NYC DCAS). The carports allow EV to run without energy provision from power grid or fossil fuel energy sources.

Notably, New York City has the largest municipal fleet among the U.S. cities, consisting of more than 30,000 cars that are owned and leased. Among them, 1,224 vehicles are on-road BEVs and PHEVs and more than 600 are off-road EVs (New York City Government, 2015). Also, the city announced in 2015 the NYC Clean Fleet, which includes a plan to use alternative fuels for city-owned vehicles (New York City Government, 2015). The Clean Fleet is actually part of the OneNYC plan according to which the city aims to reduce the greenhouse gas emission by 80% by 2050 in comparison to the base year of 2005. Among others, based on the Clean Fleet, the city disclosed vehicle information of the city-owned vehicles and arranged strategies to reduce vehicles with internal combustion engines and running on fossil fuels. The core purpose of the Clean Fleet is to encourage citizens to adopt EVs when they consider buying or changing their old automobiles. Through this plan, the city

announced its goal to add more than 2,000 EVs in their city fleet and to make the largest clean municipal fleet (EV fleet) in the U.S. by the year 2025 (Bard College, 2017). Then, they can reduce the greenhouse gas emission from the fleet by 50% in 2025 and by 80% in 2035.

〈Figure 4〉 New York City photovoltaic (PV) charging station
(Source: NYC Department of Citywide Administrative Services)

The ambitious goal may not be possible without supportive infrastructure. As of 2018, the city currently has 529 charging stations and plans to build more than 100 mobile solar power stations by 2020 (Weaver, 2018).

# Ⅳ. Discussion and conclusions

Global cities established goals and strategies to shift their polluting vehicles to cleaner ones, particularly EVs on their streets. Most of them presented an ambitious goal of electrifying 100% of their vehicles, and this encourage other competitors to electrify transportation systems. In line with this international trend, Korean metropolitan cities and provinces have established EV delivery plans and policies. For a successful shift of the transportation system of Korean cities, this study analyzed international cases focusing on European and U.S.

cases at the metropolitan level, not at the national level, in order to better identify considerations for mobility electrification. Strategies employed in major cities are summarized in Table 1.

〈Table 2〉 Electric vehicle delivery strategies of major cities in the U.S. and Europe

| Cities | Strategies | Goals | Operation types |
|---|---|---|---|
| Barcelona | Electric Mobility Strategy 2018–2024 | By 2024<br>Municipal fleet: extended to 80%<br>Electric buses: 100 vehicles<br>Private: 24,000 vehicles<br>By 2040: up to 100% in all sectors | Public and public–private partnership |
| | Electric Vehicle Master Plan | Modeling electric vehicles for public/private sectors in major metropolitan areas<br>Leading relevant procedure for the introduction of electric vehicles at a city level<br>Extensive policy introduction through cooperation between various administrations and private companies<br>Reducing inefficient and polluting fossil fuel consumption in dense residential areas<br>Incorporate electricity into universal energy sources for energy shift (generating electricity regionally through renewable ways) | |
| Berlin | E–Mobility | Seeking to create new jobs and to strengthen the economy in the long run<br>Showcasing the expertise of Germany using the competitiveness as the national capital<br>Developing and exporting new technologies and services<br>Reducing noise and air pollutants and improving the quality of life | |
| London | Electric Vehicle Infrastructure Delivery Plan | 100% zero–emission vehicles by 2030<br>Satisfying various stakeholders' needs through the city–led inclusion of related departments and private companies into the taskforce<br>Fast–charging hub installation for massive demands until 2020<br>Using on–line tools for the real–time availability of charging stations<br>Designing the guideline for the installation of charging stations | Public and public–private partnership |
| San Francisco | EV Roadmap | Short–, mid–, and long–range EV delivery plans for 2025, 2030, and 2040 (final goal: to design all trips in SF to be emission–free by 2040)<br>Public perception improvement: by 2020, all drivers and the general public will be fully aware of the major EV incentives.<br>Incentives: by 2020, EV will secure the price competitiveness (against gasoline and diesel vehicles).<br>Infrastructure: by 2022, various charging options (in terms of charging performance and charger location) will be provided.<br>Power grid: by 2025, electricity bill incentives will be arranged to make EVs economic alternatives (relative to gasoline and diesel vehicles).<br>Electrifying heavy vehicles: between 2020–2025, pilot projects will be established to adopt EV technologies for heavy vehicles.<br>Electrifying mobility services: by 2020 (and before 2025), securing strategies for fully electrifying mobility services. | |
| New York City | NYC Clean Fleet | Running 2,000 electric vehicles as city government fleets by 2025<br>Promoting positive perceptions on EVs among citizens and facilitating their EV purchases<br>Reducing emissions from government fleets by 50% in 2025 and by 80% in 2035 | Public |

As a commonality of the major EV leading cities, they established stepwise plans for the electrification of their transportation systems. Building a short-term is particularly important since the future of the EV-related industries is not solid, and the cities are equipped a plan for a short range in order to adapt themselves to the quickly changing EV world. Especially, recent technological breakthroughs in battery driving mileage and storage capacity are expected to exert a substantial impact on the EV delivery, so cities are desirable to prepare for different scenarios in (in)favorable EV-related settings. Specifically, regular monitoring and feedbacks from the monitoring to short-term strategies will allow the cities to incrementally reach their long-term goals.

Second, cities sought to adequately utilize their unique geographical and social settings for customized EV delivery plans and as a marketing strategy. For example, Berlin fully exploited its environmental image and made easily successful the growth of the EV industry. In turn, the rising penetration EV rate facilitated the growth of the renewable power generation for EV charging. In the case of New York City, the large size of municipal fleet became a target. By shifting 100% of their vehicles to be electrified, the city was capable of increasing public awareness and encouraging the public to purchase or change to EVs.

Despite their limited driving distances, EV cannot be used only for internalized trips (within the city boundary) considering recent developments in battery charging and storage technologies. Thus, EV infrastructure should be smoothly aligned in cooperation with neighboring areas. This is particularly so in the Korean capital region, consisting of Seoul Special City, Incheon Metropolitan City, and Gyeonggi Province. That is, a considerable number of people commute to Seoul from its neighboring areas. Aside from the smoothing of the transportation system, other benefits are also expected such as collaborative research and development projects. A successful example is the Berlin-Brandenburg case.

Lastly, mobility electrification cannot be realized only by an intention from a city government an ambition of a mayor. As discussed with the case of London, a firm determination of a mayor should be linked to due involvement of stakeholders in various EV-related sectors such as road transportation, environmental, and energy departments, car manufacturing businesses, power companies, and the public. London successfully reflected stakeholders' voices in decision making processes through its taskforce. Meanwhile, even among the global leaders, some announced a numeric target of EV delivery (particularly U.S. cities such as New York City and San Francisco) while others like Berlin intentionally excluded such a target and instead focused on plans on the charging infrastructure in the hope of having a positive indirect effect of the infrastructure expansion on the intention to buy EVs among the public. With regard to Korean cities, which type of goal is appropriate should be determined considering the number and size of stakeholders (stakeholder groups), their issues (interests,

positions, relationships, and resources), incentives, and timing/target years.

As a major limitation of this study, a literature on financial incentives (e.g., purchase grants and tax exemptions/deductions/credits) was not reviewed. An handsome number of case studies reported that the incentives are major determinants of EV ownership and driving. Thus, future research is advised to analyze Korean domestic and overseas studies on local and national policies on financial incentives.

## Acknowledgements

This research was supported by Graduate School of Environmental Studies Faculty Collaborative Research Project through the Environmental Planning Institute funded by Seoul National University (서울대학교 환경계획연구소 교수 융합연구과제) (Title: "EV–PV 통합형 스마트 에너지 마을에 대한 문헌연구(Literature Review on Smart Energy Neighborhood with the EV-PV Integration)").

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원 고 접 수 일 | 2019년 10월 10일
심 사 완 료 일 | 2019년 11월 4일
최종원고채택일 | 2019년 11월 5일

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서울대학교 환경대학원 환경관리전공 석사과정을 수료하였다. 주요 관심분야는 재생가능 에너지, 에너지 전환, 친환경도시이다.

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서울대학교 환경대학원 부교수, 협동과정 조경학 겸무부교수이다. 더불어 서울대학교 부설 환경계획연구소 부소장, 환경계획융복합연구실 소장을 맡고 있다. 미국 Georgia Institute of Technology에서 도시 및 지역계획학 박사를 취득하였고 Atlanta 시청 및 Georgia 주정부 연구조교/기술자, 고려대학교 시간강사, 사우디 King Fahd University of Petroleum and Minerals 조교수로 근무하였다. 주요 연구분야는 도시–교통–환경 상호작용, 삶의 질, 공간분석, 계량분석 등이다.

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서울대학교 박사과정 재학 중이다. Florida State University에서 석사학위를 받았고 에너지 분야 컨설턴트와 Florida 응급관리부 Hazard Mitigation 계획가로 근무하였다. 연구 관심사는 부동산, 성장관리, 에너지 인프라 등이다.

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서울대학교 환경대학원에서 도시계획전공 석사학위를 받았으며, 현재는 세계은행 Social Urban and Resilience Practice Group 내의 Geospatial 컨설턴트로 근무 중이다.