Seoul on the green move: Leveraging electric mobility for a sustainable city

Electric mobility has enormous potential to reach climate goals. In the City of Seoul, electrification is seen as part of a low emission mobility strategy moving towards creating a people-first, environmentally-friendly transportation system. A variety of supportive strategies are deployed to further the environmental and social benefits that electric vehicles offer.

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Importance of the issue

Electrification has never been more prominent and relevant to the debate on the future of mobility. As the technology and market for electric vehicles become mature, electrification is emerging as a viable option for cities to improve air quality, reduce noise pollution and improve urban quality of life. Cities must plan for the transition towards electric vehicles to transform urban mobility in support of sustainable development goals.

Seoul in context

Seoul, the capital of the Republic of Korea, is home to 9.7 million citizens (as of 2018) and is one of the most densely populated cities in the world. Like many other metropolitan cities around the world, Seoul and its transportation system face major challenges such as increasing greenhouse gas (GHG) emissions, air pollution, traffic congestion and road accidents. The transportation sector accounts for nearly a fifth (19.2%) of the city's total GHG emissions, reaching 9,056 tons of carbon dioxide equivalent (CO_2eq) in 2018. Increasing urbanization and economic growth are likely to further increase the pressure on existing public transportation systems.

The Seoul Metropolitan Government (SMG) has a long tradition of institutionalizing climate protection, embedding sustainability at the heart of its urban development. At the ICLEI World Congress in 2015, SMG adopted a comprehensive climate strategy "*Promise of Seoul*", setting a target of reducing GHG emissions by 40 percent by 2030 compared to 2005 levels. In 2021, SMG prepared the "*2050 Seoul Climate Action Plan (CAP)*" and established goals to achieve carbon neutrality by 2050.

Green transportation as key to addressing climate impacts

To address transportation concerns, SMG developed a long-term strategic policy. The Seoul Transport Vision 2030, an outcome of this effort, was announced in 2013 and it aims to create a people-first, environmentally-friendly transportation system. In line with the vision, Seoul has set ambitious targets and taken a host of low-emission transport measures, ranging from the establishment of green transportation zones, scaling up the adoption of electric vehicles and adopting additional targets to tackle air pollution, including increasing the share of sustainable modes of transport to 80% by 2030.

Demographic figures

Population (2020)
9,705,000
Total area (2020)
605 square kilometers (km^2)
Population density
17,000 persons/ km^2

Modal split

Passenger car: 23%
Subway: 39%
Bus: 27%
Shared mobility/ Taxi: 7%
Bicycles: 4%

Figure 1: Green transport zones in Seoul: 1 Hanyang; 2 Gangnam; 3 Yeouido. Credit: Seoul Metropolitan Government.

The introduction of low emission zone and green transportation zone

Low emission zones (LEZs) are areas where the most polluting vehicles are prohibited from traveling and are first introduced in reaction to the looming air quality crisis. In many cities worldwide, LEZs have become a widespread policy instrument to regulate access to urban cores, restrict traffic and improve air quality. Since 2017, SMG banned a total of 400,000 low-grade vehicles nationally and 100,000 vehicles within Seoul - from driving in the capital during severe air pollution periods for emission control. Since 2018, the LEZ has been extended to other adjacent local governments to collectively control the impact of emissions and air pollution in the metro area.

In July 2019, SMG designated the Seoul City Wall's inner area as the "Hanyang Green Transport Zone (GTZ, 16.7 km^2, see the figure above)", limiting the operation of Grade 5 vehicles[1] with internal combustion engines (ICE). The GTZ operates from 6:00 to 21:00 all day. The scheme, monitored via its traffic management system through 45 access points of the GTZ, gives the local authorities details of the vehicles identified in the region. Vehicles that do not meet the standards are subject to a charge ranging Korean won (KRW) 100,000 (approx. 73 Euros) once per day to KRW 200,000 (approx. 146 Euros) from the third violation. Imposing a fine on violations is also expected to enhance the public's awareness on the environment.

Since its full-scale operation in December 2019, preliminary results show that the scheme has a significant impact on reducing the number of older and more polluting vehicles, reducing congestion and improving air quality[2]. Analysis indicates that the introduction of GTZ has contributed to a reduction in overall traffic flows in the downtown area by 13.8%, and that of Grade 5 vehicles has reduced by 23.5%, after comparing the number of vehicles detected in the zone and compliance rates from December 2019 to December 2020. In addition, there was a large reduction in the number of older, more polluting, non-compliant vehicles detected in the zone: some 200 fewer on an average day, a reduction of 87%. Vehicles that were not equipped with diesel particulate filters (DPF) reduced by 58.9%. Preliminary estimates indicate that by the end of 2020, PM_{10} (particulate matter with a diameter less than 10 micrometers) reduced by 16.7% and $PM_{2.5}$, also known as fine particulate matter, reduced by 16%.

In November 2020, the SMG additionally designated the Green Transport Zones in Gangnam (30.3 km^2) and Yeouido (8.4 km^2), following the successful implementation of the Hanyang GTZ. The coverage of the new zones was decided based on land use in downtown

1 According to the Ministry of Environment guidelines, a Grade 5 vehicle refers to a small- to mid-size diesel car released before July 2002 or a gas-powered vehicle made before 1987. For large and extra-large vehicles, it refers to a diesel car released before July 2002 and a gas-powered car from before 2000.

2 http://english.seoul.go.kr/transport-webzine-post-etc/

Overall Traffic and Grade 5 Vehicle Traffic in Green Transport Zone						
Category	Overall Traffic (vehicles/day)		Grade 5 Vehicle Traffic (vehicles/day)			
			Grade 5 Vehicles		DPF Not Installed	
	Dec. 2019	Dec. 2020	Dec. 2019	Dec. 2020	Dec. 2019	Dec. 2020
Weekday	836,863	729,256 (▽12.9%)	10,945	8,414 (▽23.2%)	1,777	749 (▽57.9%)
All Days (Including weekends)	776,919	670,019 (▽13.8%)	10,222	7,823 (▽23.5%)	1,760	724 (▽58.9%)

Figure 2: Since its full-scale operation in December 2019, preliminary results show that the green transport zone has a significant impact on reducing the number of older and more polluting vehicles, reducing congestion and improving air quality. Source: Seoul Metropolitan Government.

and commercial areas, economic activities, traffic flows and city's development plans. The city government has collected citizens' opinionsthrough the administrative notice and run public consultations to promote the understanding of how it will work and the potential benefits. To secure support from relevant parties, expert review and discussions have been conducted with the Gangnam-gu Office, the Ministry of Land, Infrastructure and Transport and the Incheon Metropolitan City, as well as the local transportation committee. Smart mobility options will be explored in these two zones, for example, autonomous buses will be tested on-site and the supply of e-mobility will be increased.

Supporting measures have been introduced to ensure the benefits are equitable: the SMG provides financial support for residents of the GTZ switching to cleaner vehicles: subsidies of up to KRW 3 million (approx. 2200 Euros) are provided for the scrapping of old vehicles and the installation of a DPF in Grade 5 vehicles; up to KRW 2.5 million (around 1800 Euros) are subsidized for the purchase of low-emission vehicles on top of the scrappage scheme.

In addition, the implementation of GTZ also goes hand in hand with efforts to improve sustainable modes of transport by increasing the number of public bikes, improving bike lanes, limiting vehicle speed, and providing shared electric cars. Currently 27 green shuttle buses are running on four routes connecting Namsan to the inside and outside of the inner city. The number of city bike rentals in the GTZ increased by 67% in March 2020 from the same month of the previous year. Through the "Sejong-daero forest path" project, road space was reallocated for walkways and bike lanes.

Transition to electric mobility

Electrification of vehicle fleet in Seoul

Seoul started deploying electric vehicles (EVs) in 2009. By the end of 2020, Seoul's clean vehicle fleet consisted of 25,000 battery electric vehicles (BEVs) and fuel cell vehicles (FCVs), driven by its transport policy, rapid advances in battery technology and market. To further reduce GHG emissions and improve local air quality, Seoul aims to add an additional 270,000 EVs by 2025. To achieve this, SMG plans to add 175,000 electric cars, 62,000 electric motorcycles, 19,000 electric trucks and 10,000 electric taxis, accounting for nearly 15% of the taxi fleet.

Table 1: Numbers of electric vehicles in Seoul. Source: Seoul Metropolitan Government.

EV type	2018	2019	2025 target
Cars	N/A	N/A	175,000
Taxis	100	417	10,000 (15% of the taxi fleet)
City buses	29	89	3,500 (More than 40% of the bus fleet)
Trucks	2	451	19,000
2-wheelers	511	3384	62,000 (35,000 motorcycles, i.e. 56% of the total will be dedicated to delivery services)

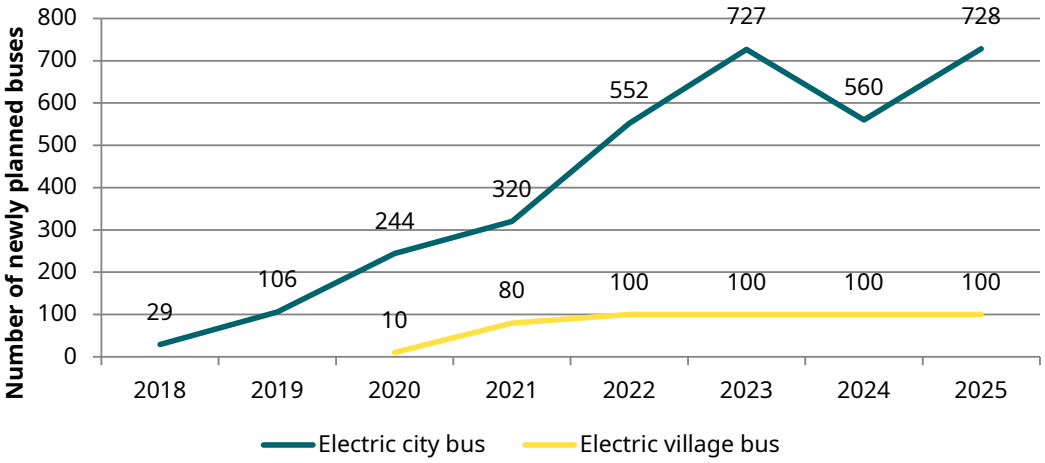

Figure 3: Seoul's e-bus development plan (as of September 2021). Unlike ci buses, the village buses ar privately operated and run the roads in the residential Source: Seoul Metropolitar Government.

Recognizing the adverse impacts caused by delivery vehicles, the city government will work with logistics service providers to accelerate the electrification of delivery vehicles by signing a memorandum of understanding (MoU) with the Ministry of Environment, the Korea Integrated Logistics Association and four logistics companies[3]. In response to the COVID-19 pandemic, more than 10% of the electric trucks will be allocated for small and medium-sized enterprises facing difficulties[4].

Starting from 2021, 295 environmentally-friendly vehicles will be provided for the municipal vehicle fleet and public bus companies are required to purchase only zero-emission vehicles. For any affiliated organizations of the SMG, it is mandatory to purchase or rent either electric or hydrogen powered vehicles.

Electrification of public transport in Seoul

Seoul's city-wide public transportation system was reformed in 2014, shifting from private to "semi-public bus system". It is a dual system in which the city government manages the bus routes, determines bus schedules and manages fare revenues while the buses are operated by private companies[5]. Since December 2018, 29 electric buses (e-buses) started to operate on three routes and in 2020, 10 electric medium-sized green village buses were introduced as a pilot. Unlike city buses, the village buses are privately operated and run on the roads in the residential areas.

As of 2020, there are 8,980 city buses running in the city, and 379 of them are electric. SMG plans to add a total of 3,500 city buses to its public bus fleet by 2025, including 490 green village buses. This will make more than 40% of Seoul's bus fleet electric.

Vehicle purchase subsidies

Seoul allocated its budget for deploying electric vehicles alongside the financial support of the central government. Depending on the vehicle type and its fuel efficiency, financial support will be provided to the original equipment manufacturers (OEMs) or vehicle importers, benefiting the consumers indirectly. In particular, electric trucks' subsidies have been exceptionally robust, allowing lower prices than comparable diesel trucks through Seoul and the central government's subsidies. Seoul also provides fast tracks to those who have an electric commercial vehicle and apply for a transportation business license.

Financing the procurement of buses is often one of the most frequently listed challenges for cities in moving towards electrification as the capital costs of e-buses may be two to three times more than those of diesel buses. In Seoul, the SMG provides up to 200 million Korean won (approximately 148,800 Euros) when bus operators replace diesel buses with e-buses. The e-bus supply plans are discussed between the SMG and the private bus service providers, by taking into account the number of passengers, bus routes, manufacturing years, and charging facilities.

3 http://english.seoul.go.kr/delivery-motorcycles-and-trucks-in-seoul-go-100-electric-by-2025/

4 http://english.seoul.go.kr/seoul-to-supply-12000-electric-vehicles-in-2021-totaling-over-40000/

5 Intra-city bus: No. of Companies 66, No. of vehicles 7,485, No. of Bus Lines 361; Green village bus: No. of Companies 131, No. of vehicles 1,470, No. of Bus Lines 237.

Figure 4: Electric city bus. Credit: Seoul Metropolitan Government.

Figure 5: Fast charger for e-buses. Credit: Korea Electric Power Corporation (KEPCO).

The dominant e-bus model in Seoul is 10.9 meters long with 23 passenger seats. It is equipped with a battery over 200 kilowatt hour (kWh) and has a 260 kilometer (km) driving range, characterized by a charging speed of 26 kWh per minute in the winter season. The vehicle manufacturers provide 9 years of warranty for the battery, motor and the electronic components.

Charging infrastructure

The prerequisite of charging infrastructures is essential for the large-scale adoption of EVs. The SMG plays an active role in rolling out charging points and aims to have 200,000 charging stations installed by 2025. Fast charging will be provided at transportation hubs and public facilities while slow charging stations will be installed in residential areas. To date, Seoul has the second largest public EV charging infrastructure after Gyeonggi, with 917 fast chargers and 7,589 slow chargers[6]. Currently two innovative models of EV chargers, streetlight-shaped chargers and bollard-shaped chargers are piloted in prioritized residential parking areas and roadside to ensure high quality, affordable charging for local residents[7]. The streetlight-shaped charger is a 50kW rapid charger equipped with streetlights and CCTVs, allowing EVs to be fully charged in an hour. The bollard-shaped charger is a slow charger and takes up only 0.06 square meters of road space.

As with other upfront costs of e-buses, those of charging infrastructure installation and equipment range widely depending on the charging type selected and the existing local grid. For the construction of fast chargers in Seoul, the SMG provides 50 million Korean won (approximately 37,200 Euros) to bus operating companies/ charging service providers. It is estimated that a fast charger can charge an e-bus per hour at 300 kWh and overnight it could charge up to 5 buses. In 2021, 80 fast chargers are planned to meet the charging demand for 400 e-buses in the capital.

Battery recycling

The management of battery technology is closely integrated with the charging strategy and remains a key issue in the wider roll out of e-buses, notably battery life, battery disposal and the replacement-cost risk of batteries. A battery is typically considered to have reached the end of its life when it has less than 80 percent of its original capacity. In 2020, EV owners in South Korea who received subsidies must return the waste batteries back to city governments before scrapping. Since 2021, the

6 https://www.ev.or.kr

7 http://english.seoul.go.kr/seoul-sets-up-streetlight-shaped-and-bollardshaped-ev-chargers-in-neighborhood-alleys/

Figure 6: The SMG has installed an EV charging station using waste batteries and solar panels. Credit: Seoul Energy corporation.

relevant regulations have been updated and it is not mandatory to return the batteries. As such, the private sector can collect, store, and recycle the waste batteries.

In addition, the national government has established four waste resources collection centers to promote the recycling of used EV batteries and other related resources such as solar panels[8]. The waste batteries are collected from the EV owners and their residual value, e.g. remaining capacity and residual life will be measured. They will then be sold to private companies and recycled either via an energy storage system or an electric bike battery through repair and reassembly. In Seoul, the city government has installed an EV charging station using waste batteries and solar panels for promoting the use of waste batteries.

Adoption of hydrogen fuel cell buses

Seoul announced its Green New Deal in July 2020, committing to efficient and eco-friendly transportation. As part of the Deal, the SMG introduced the first four fuel cell e-buses in December 2020. These hydrogen buses run on its intra-city route 370, covering the major points of the capital as well as the GTZ. The bus route is chosen based on its proximity to a hydrogen station and could run 240-250km per day when fully fueled. Seoul is planning to increase the number of hydrogen-powered buses to 1,000 by 2025 and to establish 11 hydrogen stations[9]. To further encourage the transition to fuel cell vehicles, the city provides purchase subsidies as well as an array of tax reduction benefits similar to EV.

Use of the intelligent transportation system

Electrification works concurrently with data and technology as real-time data from the vehicles and charging facilities can be collected and drive informed decision-making. While there is a general lack of evidence and reliable data sources of e-bus performance, Seoul uses the Transport Operation & Information Service (TOPIS) system to collect data and support efficient and safe operations of its fleets.

TOPIS integrates information from major public and private traffic information centers, including the Bus management System (BMS), the Seoul Bicycle Road System, the transport card system, the CCTV System, Seoul police station, and the Korea highway corporation.As such, the system provides information on bus operations, public transport ridership, traffic volume, vehicle speed, parking road accidents as well as traffic conditions and service performance in real time. The real-time traffic information not only helps improve user experience, but also helps the city government to alleviate congestion and plan for evidence-based transportation policies. SMG

8 https://www.law.go.kr/LSW/lsInfoP.do?efYd=20210706&lsiSeq=233721#0000

9 https://english.seoul.go.kr/citywide-operation-of-eco-friendly-hydrogen-powered-buses/

also uses the TOPIS to identify the areas with high public transport ridership and prioritize the sections or routes for the replacement of conventional buses with e-buses.

Lessons learned for replication

While a growing number of cities have deployed e-buses, there are a number of barriers, such as lack of political support, high cost, vehicle range and a lack of operational data, to name a few. Many of these challenges are not uncommon for emerging technologies in the transportation sector and will lessen as the technologies become mature and data becomes more evident. In Seoul, the city government deployed a range of measures to address these challenges and accelerate the transition to e-mobility.

Align policies with the city's long-term sustainability agendas

First and foremost, it is evident that electrification alone does not make a transportation system more sustainable, nor does the application of new technologies. Electrification of vehicle fleets is considered a part of the low emission mobility strategies moving towards a people-first, environmentally-friendly transportation system.

The transition to e-mobility requires coordination and policy synergy across different levels of governments as well as different departments within the governments. Private players especially in vehicle manufacturing, charging technologies and battery technologies are also critical. The government mandate to shift to EVs and FCVs - accompanied by national and local government subsidies that significantly lower the upfront costs - supported the fast electrification of the vehicle fleet in Seoul. In addition, significant efforts have also been made in the capital to increase the availability of charging stations and to support battery recycling and reuse.

Integrate bus service with other sustainable modes of transport

Electrification of public transportation, when planned with connected and accessible communities that encourage short walking and cycling trips, can significantly increase its environmental and social benefits. In Seoul, limited urban space is re-allocated from cars to pedestrians and cyclists. This includes reduction of traffic lanes to 4 lanes or less, and more space is allocated for central bus lanes as well as sidewalk and bike lanes. Besides, Cycle Rapid Transportation (CRT) has been built in major areas in the city, which provides exclusive cycling infrastructure and facilitates faster, safer and more convenient cycling experience. The SMG plans to gradually extend cycle lanes from the current 940 km to a total of 1,330 km by 2030. In addition, to incentivize the use of public transport, Seoul has a plan to increase the public parking fees in areas where public transport is easily accessible.

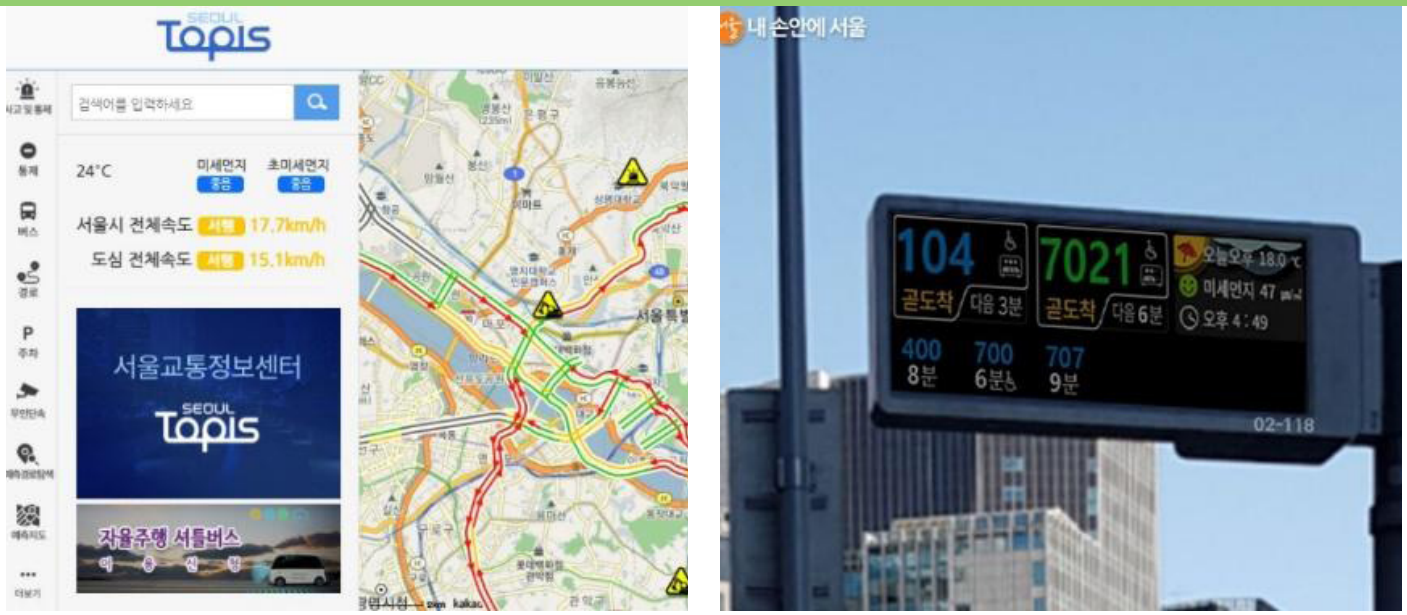

Figure 7: TOPIS Screen (left), BMS (right). Source: Seoul Metropolitan Government.

References

Seoul Climate and Environment Headquarters, 2021. 2050 Seoul Climate Action Plan, Seoul Metropolitan Government.

Seoul Climate and Environment Headquarters, 2021. Electric vehicle supply announcement (21 Jul 2021), Seoul Metropolitan Government.

Seoul Climate and Environment Headquarters, 2021. Press release (31 Aug 2021), Seoul Metropolitan Government.

Seoul Metropolitan Transportation Headquarters, 2020. Press release (05 Nov 2020), Seoul Metropolitan Government.

Seoul Metropolitan Transportation Headquarters, 2016. Seoul transport policy, Seoul Metropolitan Government.

The Department of the Environment, 2021. Press release (16 Aug 2021), Korean National government.

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