BRIEFING

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A global overview of zero-emission zones in cities and their development progress

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A zero-emission zone (ZEZ) is an area where only zero-emission vehicles (ZEVs), pedestrians, and cyclists are granted unrestricted access. Other vehicles are either prohibited from entering or permitted to enter upon payment of a fee. Based on recent publicly available information, this briefing provides a detailed overview of the cities that have implemented or have plans to implement ZEZs and variants, and includes the progress each has made. These cities are pioneers that showcase how ZEZs can be developed, and others can learn from their experiences.

In this paper, ZEVs are vehicles that do not produce tailpipe pollutant emissions at any point of use, and this means battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). Some zones extend unrestricted access to plug-in hybrid electric vehicles (PHEVs), which are capable of producing zero tailpipe emissions when operating in the zones, and we refer to these as near-zero-emission zones (near-ZEZs). Zones that further extend unrestricted access to any other vehicles besides ZEVs and PHEVs, such as non-plug-in hybrid electric vehicles (HEVs) and compressed natural gas (CNG) vehicles, are not treated as variants of ZEZs and are thus excluded from this paper.

ZEZs could provide important support for the shift away from internal combustion engine (ICE) vehicles to ZEVs and these zones also have the potential to encourage mode shift from driving to walking, biking, or mass transit. However, pedestrian and cyclist-only zones (i.e., vehicle-free zones) are not discussed in this paper.

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OVERVIEW OF ZERO-EMISSION ZONE DEVELOPMENT PROGRESS

As of July 2021, several dozen cities globally, most of them in Europe, had implemented or announced plans to implement ZEZs and near-ZEZs. Some of these are pilot programs and others are permanent schemes (see Figure 1). In the United Kingdom, two London boroughs have jointly implemented a near-ZEZ that affects a few streets, City of London is piloting a near-ZEZ covering one street, and Oxford will be piloting a small-scale ZEZ in 2021 to accumulate experience and inform the implementation of a larger ZEZ in 2022. Additionally, Amsterdam, Netherlands, Oslo, Norway, and Paris, France all have detailed plans to implement ZEZs in a phased manner in the coming decade.

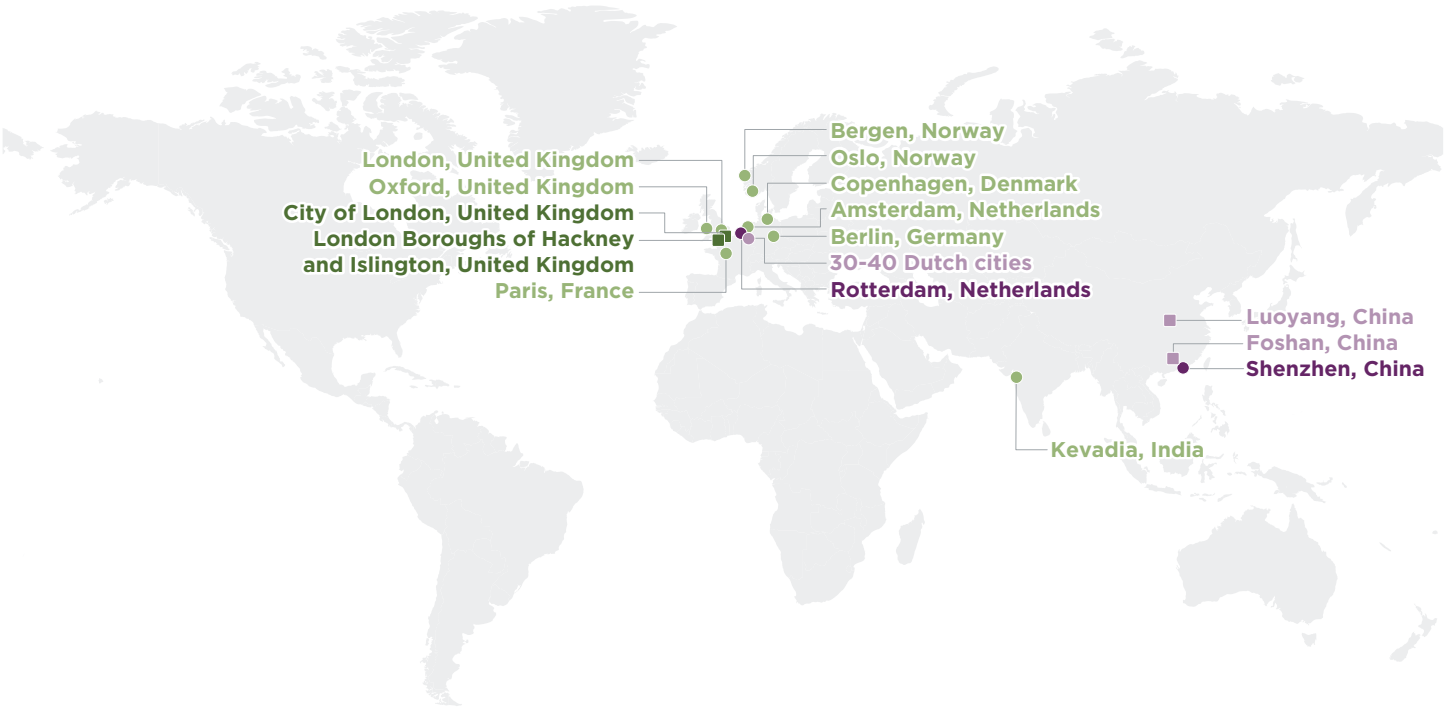
Considering the great contribution of freight transportation to toxic air pollutants and greenhouse gas (GHG) emissions, and freight's reliance on diesel-powered vehicles, it is unsurprising that some cities have chosen to establish zones focusing entirely on freight vehicles.[1] These zones are highlighted in this paper as zero-emission zones for freight (ZEZ-Fs) and near-zero-emission zones for freight (near-ZEZ-Fs). Rotterdam, Netherlands has implemented a permanent ZEZ-F and Shenzhen, China is piloting one. The Dutch government has announced plans to implement ZEZ-Fs in 30–40 of the country's largest cities by 2025. Two Chinese cities, Luoyang and Foshan, have both announced plans to implement a near-ZEZ-F.

This progress on ZEZ development has occurred in the context of an increasingly rapid global transition to electric vehicles like BEVs, FCEVs, and PHEVs.[2] Continuous improvements regarding electric vehicle availability, maturity, and affordability have been a breeding ground for ZEZs and near-ZEZs. Their establishment, in turn, is expected further stimulate the deployment of electric vehicles, and contribute to the achievement of cities' air quality and GHG emissions reduction goals.

1 C40 Cities, Transport Decarbonisation Alliance, and POLIS, *How-to Guide on Zero-Emission Zones – Don't Wait to Start with Freight*, (December 2020), https://www.greengrowthknowledge.org/guidance/how-guide-zero-emission-zones-don%E2%80%99t-wait-start-freight

2 Hongyang Cui, Dale Hall, and Nic Lutsey, *Update on the Global Transition to Electric Vehicles Through 2019*, (ICCT: Washington, DC, 2020), https://theicct.org/publications/update-global-ev-transition-2019

Cities with implemented and planned zero-emission zones and variants globally* (Status: July 2021)



	Zero-emission zone	Near-zero-emission zone
Implemented	–	■
Planned	●	–

	Zero-emission zone for freight	Near-zero-emission zone for freight
Implemented	●	–
Planned	●	■

*Zero-emission zones grant unrestricted access to battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) only. In addition to BEVs and FCEVs, near-zero-emission zones grant unrestricted access to plug-in hybrid electric vehicles (PHEVs). Zones for freight are defined in different ways, with affected vehicles ranging from urban delivery vehicles to medium- and heavy-duty trucks. Affected areas of zones range from a few streets to an entire city.

Figure 1. Cities with implemented and planned ZEZs and variants globally as of July 2021.

IMPLEMENTED SCHEMES

As of July 2021, there are two near-ZEZs and two ZEZ-Fs implemented. These include the near-ZEZ in the London Boroughs of Hackney and Islington, the near-ZEZ pilot in the City of London, the ZEZ-F in Rotterdam, and the ZEZ-F pilot in Shenzhen. All of these are small in scale and the affected areas range from one street to around 20 square kilometers.

LONDON BOROUGHS OF HACKNEY AND ISLINGTON (UNITED KINGDOM)

Launched in September 2018, this cross-borough near-ZEZ covers five streets, locally referred as Ultra-Low Emission Streets.[3] The scheme aims to reduce vehicle pollution during commuting hours and make it easier and safer to walk and cycle.

As shown in Figure 2, this near-ZEZ affects two streets in Hackney (Rivington Street and Charlotte Road) and three streets in Islington (Tabernacle Street, Singer Street, and Cowper Street). The restrictions apply to all categories of vehicles, and to minimize the disruption to residents and businesses, this zone only operates during peak hours:

3 Hackney, "Ultra Low Emission Streets," accessed July 15, 2021, https://hackney.gov.uk/ulev-streets. Map reproduced under the Open Government Licence, http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/. Note, also, that these ultra-low emission streets are different from the London ultra-low emission zone, which also allows internal combustion engine (ICE) vehicles to enter as long as they are compliant with specific emission standards.

7 am to 10 am and 4 pm to 7 pm on weekdays. Only vehicles with CO_2 emissions no higher than 75 g/km and a zero-emission range of at least 10 miles are allowed to drive through these streets during the peak periods. This includes BEVs, FCEVs, and the cleanest PHEVs. Enforcement is performed by automatic number plate recognition cameras. In case of a violation, drivers must pay a penalty of £130 (US$180)[4], but this is reduced to £65 (US$90) if paid within 14 days.

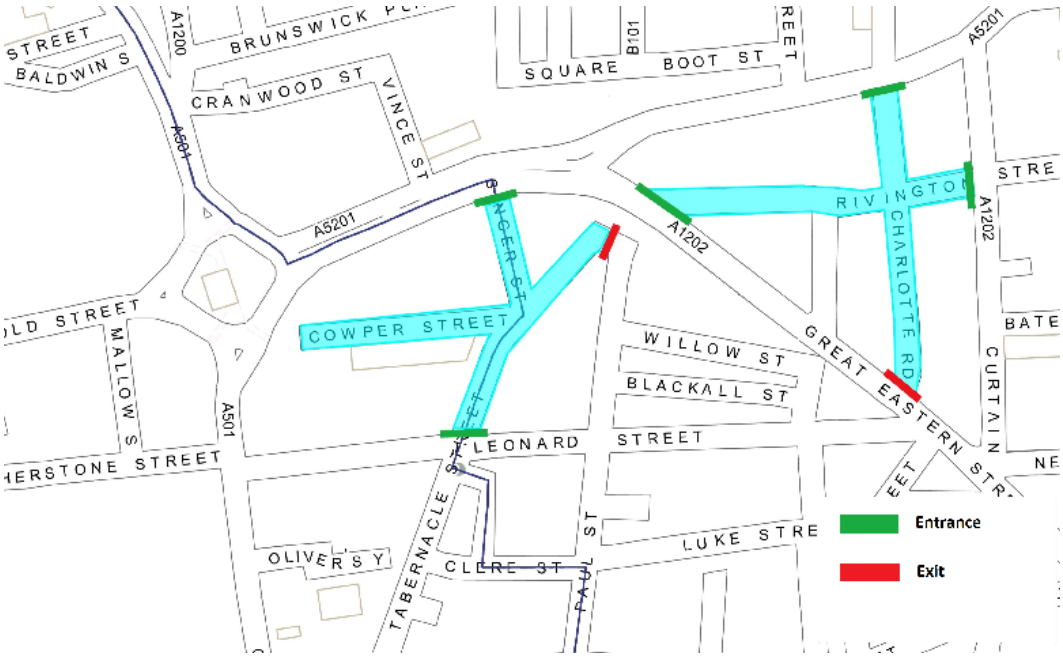


Figure 2. The cross-borough near-ZEZ in Hackney and Islington.

CITY OF LONDON (UNITED KINGDOM)

In March 2020, the City of London launched a near-ZEZ pilot covering one 360-meter long street called Beech street, the majority of which is a tunnel under the Barbican Estate (Figure 3). The pilot was launched because the street was experiencing high levels of air pollution and it is locally referred to as a Zero Emission Street.[5] The scheme aims to improve air quality and deliver health benefits for pedestrians and cyclists on the street and in the surrounding area.

The pilot applies to all categories of vehicles and operates 24 hours a day, 7 days a week. Only vehicles emitting up to 75 g CO_2/km, with a zero-emission range of at least 20 miles and which are compliant with Euro 6-equivalent emission standards for nitrogen oxides (NO_x), are allowed to drive along Beech Street. This includes BEVs, FCEVs, and the cleanest PHEVs. The scheme is enforced with automatic number plate recognition cameras. From July 27, 2020 onward, violating drivers receive a penalty notice and the penalties can be up to £130 (US$180).

4 In this paper, we apply the exchange rate of 1 British pound = 1.38 US dollars, 1 euro = 1.18 US dollars, and 1 Chinese yuan = 0.15 US dollars. These were the rates on July 15, 2021.

5 City of London, "Beech Street Experimental Traffic Order," May 28, 2021, https://www.cityoflondon.gov.uk/services/streets/traffic-schemes-and-proposals/beech-street-experimental-traffic-order

Figure 3. The near-ZEZ pilot in the City of London. Image provided by the City of London Corporation.

This pilot will run for up to 18 months and this period will include consultation with residents, businesses, and road users via phone calls or videocalls. The City of London Corporation will monitor the zone's impact on air quality and traffic. If the pilot is deemed successful, this near-ZEZ might become permanent.

ROTTERDAM (NETHERLANDS)

In January 2015, Rotterdam implemented a ZEZ-F covering a 1.6-kilometer long street called 's-Gravendijkwal. This is an important through road situated in the west of Rotterdam's center (Figure 4) and the scheme is one of the city's measures to improve local air quality.[6]

This ZEZ-F applies to trucks with a gross vehicle weight of 3.5 tons or more and operates 24 hours a day, 7 days a week. Only ZEVs are allowed to drive on the street. The scheme is enforced by an automated camera recognition system. Non-compliant vehicles face a penalty of €95 (US$112) plus a €9 (US$11) administration fee.

6 City of Rotterdam, "Vrachtautoverbod 's-Gravendijkwal [Truck ban in 's-Gravendijkwal]," https://www.rotterdam.nl/werken-leren/sgravendijkwal/

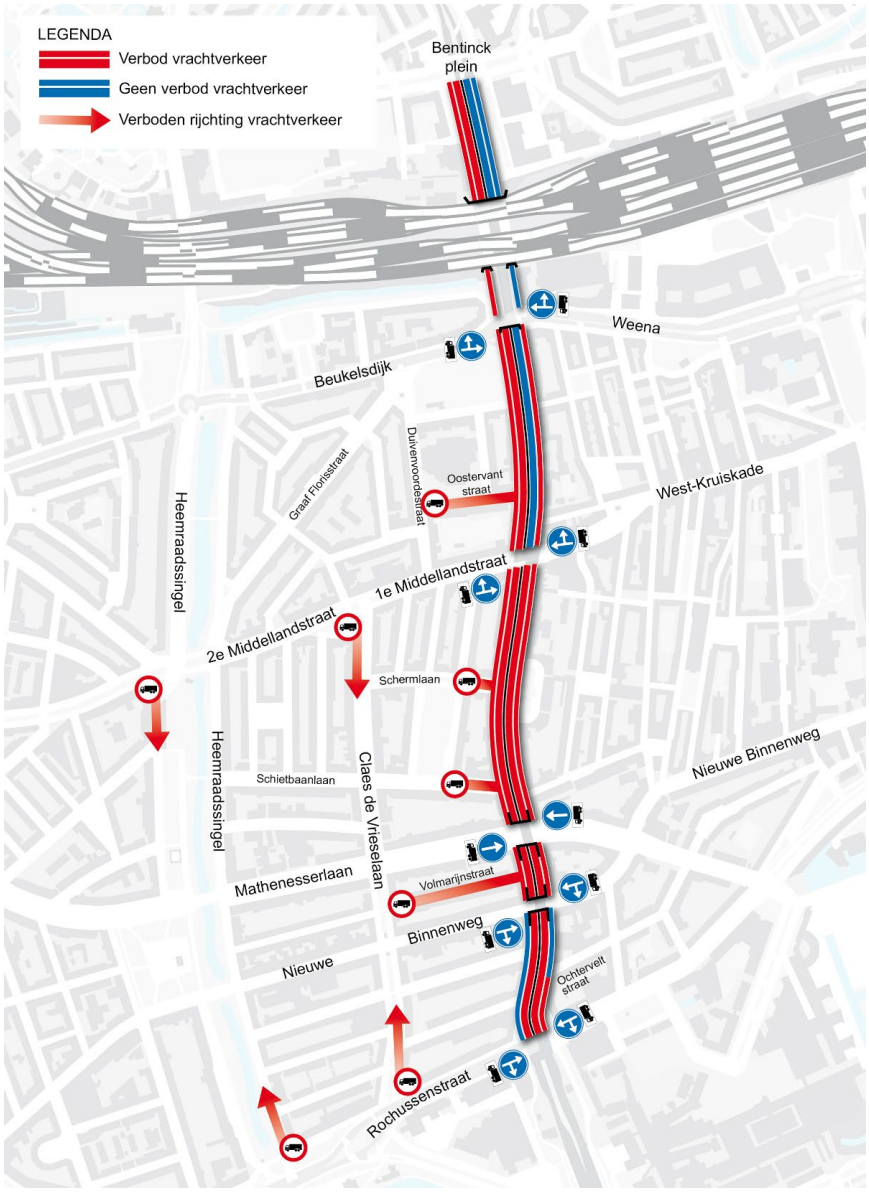


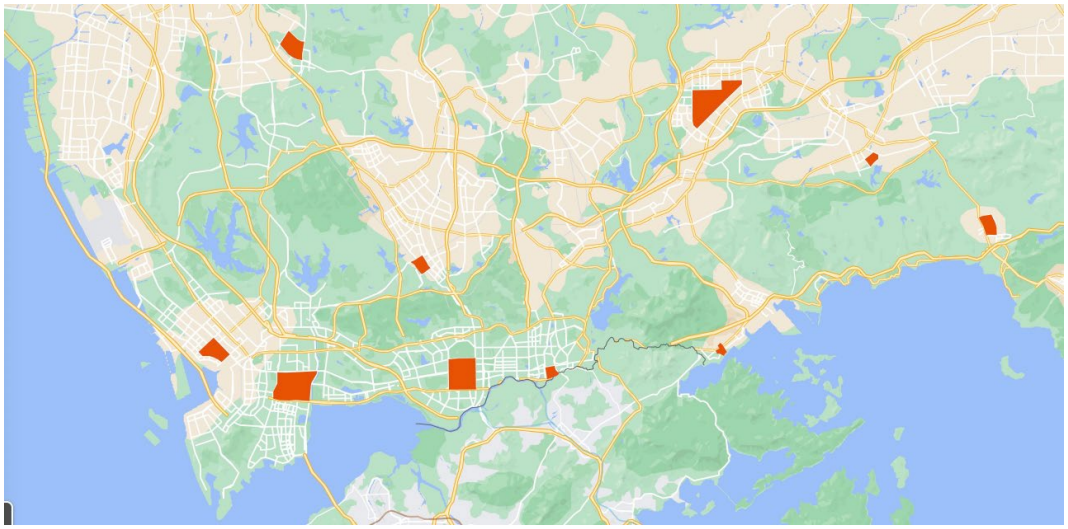
Figure 4. The ZEZ-F in Rotterdam.

SHENZHEN (CHINA)

In July 2018, Shenzhen implemented a ZEZ-F pilot that covers an area of 22 square kilometers dispersed in the city's 10 district-level jurisdictions and accounts for 1.1% of the total city area (Figure 5). It is locally referred to as a Green Logistics Zone.[7] The scheme is one of Shenzhen's measures to improve local air quality.

This ZEZ-F pilot applies to light-duty trucks with a gross vehicle weight less than 4.5 tons and operates 24 hours a day, 7 days a week. Only ZEVs are allowed to drive through the streets affected. The scheme is enforced by the police. Non-compliant drivers are subjected to a fine of CNY 300 (US$45) and receive 3 points toward China's 12-point system. If 12 points are accumulated, the license of the driver is suspended temporarily.

7 Shenzhen Public Security Bureau, "关于继续设置绿色物流区禁止轻型柴油货车通行的通告 [Notice on Continuing Green Logistic Zones to Ban the Use of Light-duty Diesel Trucks]," January 5, 2021, http://ga.sz.gov.cn/gkmlpt/content/8/8394/post_8394656.html#808



Shenzhen zero-emission zone for freight

Figure 5. The ZEZ-F pilot in Shenzhen. *Source*: Google Maps.

This pilot scheme has been continuously extended since it was implemented, except for a temporary suspension in 2020 due to COVID-19. The end date of the latest extension is July 21, 2022. The Shenzhen Public Security Bureau has not yet announced whether the scheme will be made permanent.

PLANNED SCHEMES

There are a number of planned ZEZs and near-ZEZs under development. Leading cities have already approved the scheme proposal (e.g., Oxford) or have detailed proposals ready for discussion (e.g., Oslo), and the others are still at the initial stage and have not made concrete progress on scheme design.

OXFORD (UNITED KINGDOM)

Oxford plans to implement a ZEZ pilot covering several streets in late 2021 and a larger ZEZ covering most of Oxford city center in spring 2022.[8] The scheme is one of the city's measures to improve air quality.[9] The goal is to gain experience from the pilot and inform the implementation of the larger ZEZ.

The proposal for the ZEZ pilot was formally approved by the Oxfordshire County Council in March 2021 after three rounds of public consultation, first in 2018, then again in January 2020, and finally in November 2020. There will be another round of public consultation in summer 2021 to discuss the proposed scheme for the larger ZEZ.

The pilot scheme applies to eight streets in Oxford's city center, marked in red in Figure 6. The areas marked in green (around 1.6 square kilometers) are those affected by the proposed larger ZEZ. Both the pilot scheme and the larger ZEZ apply to all categories of vehicles and operate between 7 am and 7 pm on all days of the week. They will be implemented through a road user charging scheme. Only ZEVs will be allowed to drive in the zone free of charge during operating hours. Other vehicles will be subject to daily charges, depending on their CO_2 emission levels. Table 1 shows the daily charges

8 Oxford City Council, "Zero Emission Zone Pilot Approved for August Launch by Oxfordshire County Council's Cabinet," March 16, 2021, https://www.oxford.gov.uk/news/article/1755/zero_emission_zone_pilot_approved_for_august_launch_by_oxfordshire_county_councils_cabinet; and Oxford City Council, "Statement on ZEZ Pilot," July 8, 2021, https://www.oxford.gov.uk/news/article/1899/statement_on_zez_pilot

9 Oxford City Council, "Oxford Transport Strategy," accessed July 15, 2021, https://www.oxford.gov.uk/downloads/download/557/oxford_transport_strategy

that drivers are required to pay under the ZEZ pilot. The same charges are proposed for the larger ZEZ from spring 2022 and there is a proposal that they double after August 2025, but this will undergo further technical work and public consultation in 2021. Enforcement will be done by automatic number plate recognition cameras. Daily charges are to be paid before entering the zone or by midnight on the day after entering the zone. If the daily charges are not paid on time, penalty charges between £60 (US$85) and £180 (US$256) apply, depending on the time issued.

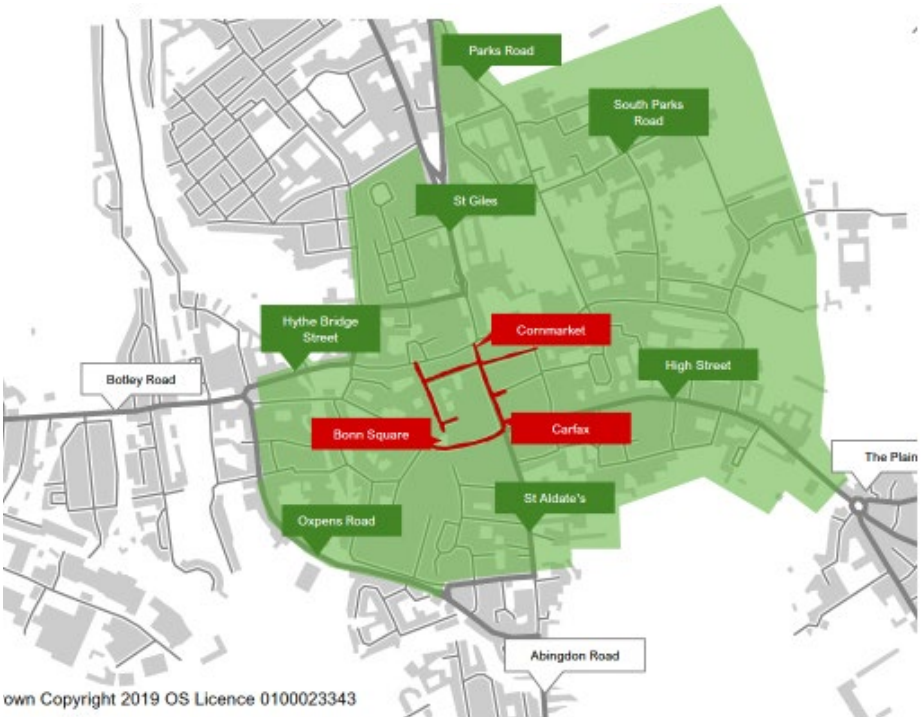


Figure 6. The planned ZEZ pilot (in red) and larger ZEZ (in green) in Oxford.

Table 1. Daily charges to enter the Oxford ZEZ and proposed charges from 2025 onward.

Vehicle type	Daily charges	
	Late 2021 to July 2025	August 2025 onward (proposed)
Zero-emission vehicles emitting 0 g CO_2/km	£0 (US$0)	£0 (US$0)
Vehicles emitting less than 75 g CO_2/km	£2 (US$2.8)	£4 (US$5.5)
Vehicles emitting 75 g CO_2/km or more but are compliant with the Euro 4 emission standard for gasoline vehicles or the Euro 6 emission standard for diesel vehicles	£4 (US$5.5)	£8 (US$11)
Vehicles not meeting any of the above emission criteria	£10 (US$13.8)	£20 (US$27.6)

Oxford is the only city, as of July 2021, choosing to implement its ZEZ through a road user charging scheme. At the initial stage of scheme development, other options were considered. The Oxfordshire County Council and Oxford City Council finally selected the charging scheme because they believe it represents the fairest balance between accelerating the transition to a zero-emission transport system and maintaining access for residents, businesses, and visitors. More polluting vehicles are charged rather than banned in the zone, and this allows local authorities to gradually strengthen the requirements over time, as the availability and affordability of ZEVs improves further. In the meantime, the city envisions that the charging scheme will generate income

that could be used to support the transition to ZEVs, for example by providing vehicle charging infrastructure and to support schemes that promote mode shift to walking, cycling, and public transport.

OSLO (NORWAY)

Oslo plans to implement a ZEZ in the city center during the City Government's current term (i.e., between 2019 and 2023).[10] The scheme aims to reduce GHG emissions and improve local air quality. It is expected to avoid a minimum of 5,000 tons of CO_2 emissions per year and contribute to the city's 2030 target to reduce GHG emissions by 95% when compared to 2009 levels.[11]

In 2020, the Oslo City Council commissioned the Urban Environment Agency and the Climate Agency to formulate and evaluate scheme options for the planned ZEZ.[12] Based on the feasibility analysis that resulted, the City Council proposed an implementation plan and has requested that the two agencies conduct further assessment.[13]

According to the current proposal, the planned ZEZ in Oslo would commence with the city's Car-Free City Life area,[14] where pedestrians and cyclists take precedence over private cars, by 2022 and be expanded to Ring 2 by 2026. The Car-Free City Life area is shown in green in Figure 7 (around 1.3 square kilometers) and the expanded area is all colored areas (around 13 square kilometers). It will operate 24 hours a day, all year long. Only ZEVs will be allowed to enter the ZEZ. It will apply to light-duty vehicles first and include heavy-duty vehicles by 2023; however, Oslo is considering granting access to both zero-emission and biogas heavy-duty vehicles. This scope as it applies to heavy-duty vehicles is not finally decided yet. The enforcement and penalties of the planned ZEZ in Oslo have also not been specified yet. Based on the aforementioned feasibility analysis, the zone might be enforced by the police or by automatic number plate recognition cameras.

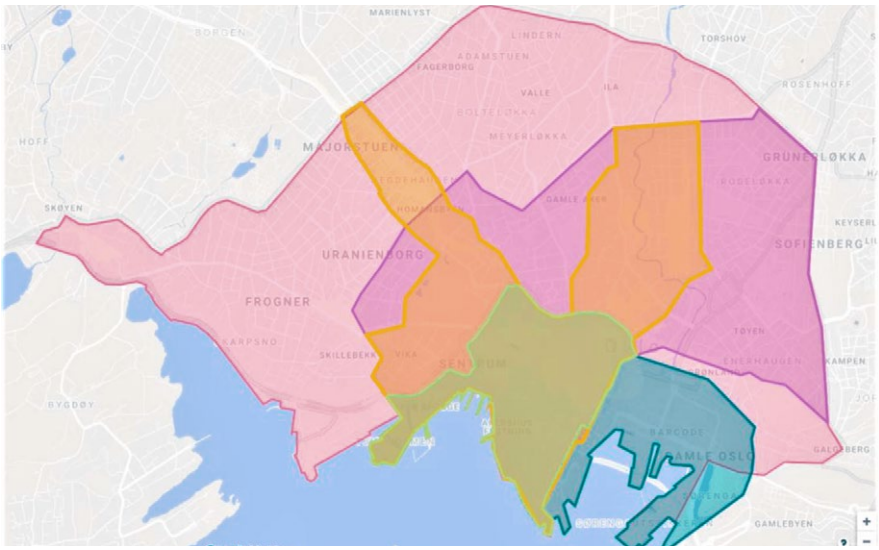


Figure 7. The planned ZEZ in Oslo. Image from City of Oslo.

10 City of Oslo, "Climate Budget 2021," https://www.klimaoslo.no/wp-content/uploads/sites/88/2021/02/Climate-Budget-2021-Oslo.pdf

11 Oslo City Council, "Climate and Energy Strategy for Oslo," June 22, 2016, https://www.klimaoslo.no/wp-content/uploads/sites/88/2018/06/Climate-and-Energy-Strategy-2016-English.pdf

12 City of Oslo, "Utredning nullutslippsoner [Investigation of Zero Emission Zones]," https://www.klimaoslo.no/wp-content/uploads/sites/88/2021/02/Rapport-om-nullutslippssoner-faglig-grunnlag-for-videre-arbeid-med-bestilling-Redusert-filstorrelse.pdf

13 Climate Oslo, "Dette er forslagene til nullutslippssone [These Are the Proposals for the Zero Emission Zone]," February 4, 2021, https://www.klimaoslo.no/2021/02/04/forslagene-til-nullutslippssone-i-oslo/

14 City of Oslo, "Bilfritt byliv [Car-Free City Life," https://www.oslo.kommune.no/slik-bygger-vi-oslo/bilfritt-byliv/#gref

AMSTERDAM (NETHERLANDS)

Amsterdam has a low-emission zone (LEZ) in place and plans to progressively upgrade it to a ZEZ covering the entire city area by 2030.[15] The scheme aims to improve local air quality, and a goal is to meet the World Health Organization (WHO)'s air quality guidelines from 2030 onward.

The current LEZ in Amsterdam covers the entire built-up area (green boundary in Figure 8) for mopeds and scooters, and covers the central urban area within the A10 ring road (orange boundary) for all the other vehicle categories. It operates 24 hours a day, 7 days a week. Only vehicles that meet specific emissions criteria are allowed to enter the zone (Table 2). Enforcement is performed by automatic number plate recognition cameras. Fines for non-compliant vehicles are €70 (US$86) in the case of mopeds and scooters, €100 (US$122) for passenger cars, taxis, light commercial vehicles, and buses/coaches, and €250 (US$306) for trucks.

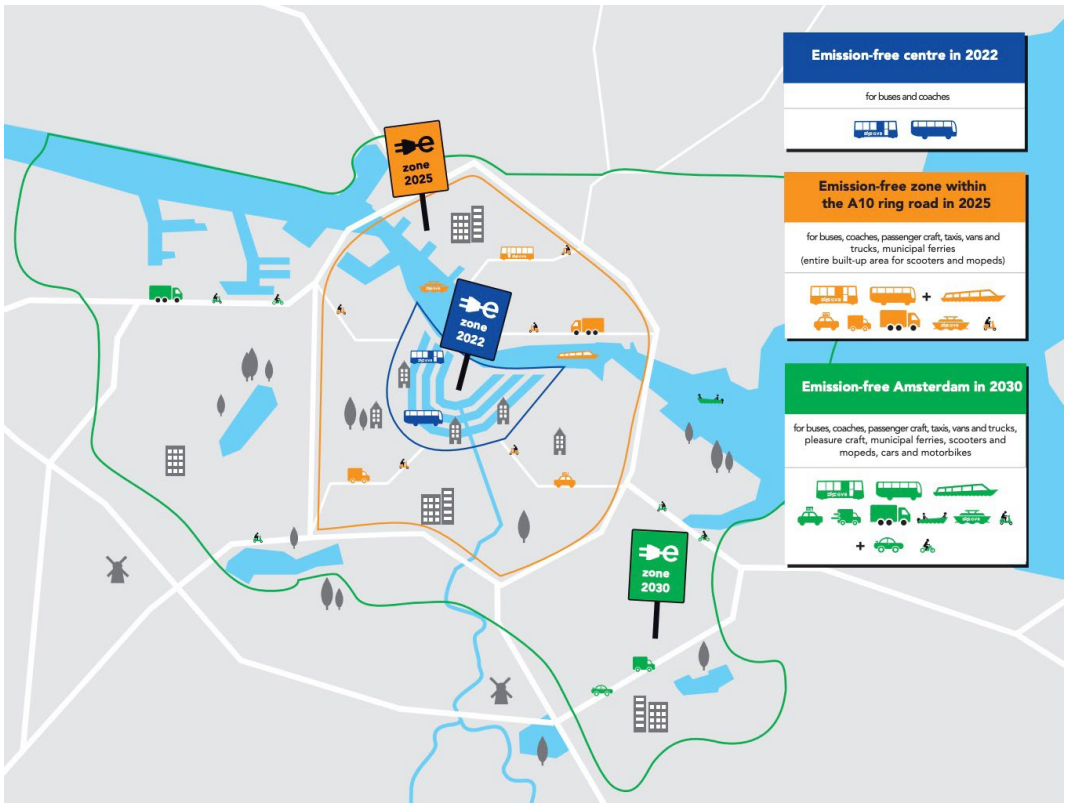


Figure 8. The planned ZEZ in Amsterdam.

The planned ZEZ in Amsterdam will cover the city center (blue boundary in Figure 8, around 6.5 square kilometers) by 2022 and be expanded to the A10 ring road (orange boundary, around 70 square kilometers) by 2025. It will be further expanded to the entire built-up area (green boundary) by 2030.[16] As planned, the 2022 ZEZ covering the city center will apply to buses and coaches only. The 2025 ZEZ, which will overlap with the current LEZ, will apply to all vehicles except passenger cars. By 2030, all modes of transport will be covered by the city-wide ZEZ. Table 2 shows the progressively tightened emissions criteria.[17]

15 City of Amsterdam, "Low Emission Zone," accessed July 15, 2021, https://www.amsterdam.nl/en/traffic-transport/low-emission-zone/

16 City of Amsterdam, *Clean Air Action Plan*, (October 2019), https://www.amsterdam.nl/en/policy/sustainability/clean-air/

17 City of Amsterdam, "Environmentally-Friendly Buses and Coaches", accessed July 15, 2021, https://www.amsterdam.nl/veelgevraagd/?productid=%7Bd0afa7ee-c6ea-461b-ba6d-b49916ae7301%7D#case_%7BFA207FEC-DE8C-4CA7-B4CF-DD3B69614AF7%7D

Table 2. How the emissions criteria for the Amsterdam LEZ are progressively tightened toward the ZEZ.

Vehicle category		Vehicles allowed to enter										
		City center				Outside city center but within A10 ring road				Outside A10 ring road but within the built-up area		
		2021	2022	2025	2030	2021	2022	2025	2030	2021	2025	2030
Passenger cars	**Diesel**	Euro 4/5/6 vehicles, ZEVs			ZEVs	Euro 4/5/6 vehicles, ZEVs			ZEVs	All		ZEVs
	Non-diesel	All			ZEVs	All			ZEVs	All		ZEVs
Taxis	**Diesel**	Euro 5/6 vehicles, ZEVs		ZEVs		Euro 5/6 vehicles, ZEVs		ZEVs		All		ZEVs
	Non-diesel	All		ZEVs		All		ZEVs		All		ZEVs
Vans	**Diesel**	Euro 4/5/6 vehicles, ZEVs		ZEVs		Euro 4/5/6 vehicles, ZEVs		ZEVs		All		ZEVs
	Non-diesel	All		ZEVs		All		ZEVs		All		ZEVs
Trucks	**Diesel**	Euro 4/5/6 vehicles, ZEVs	Euro 6 vehicles, ZEVs	ZEVs		Euro 4/5/6 vehicles, ZEVs	Euro 6 vehicles, ZEVs	ZEVs		All		ZEVs
	Non-diesel	All		ZEVs		All		ZEVs		All		ZEVs
Buses and coaches		Euro 4/5/6 vehicles, ZEVs	ZEVs			Euro 4/5/6 vehicles, ZEVs		ZEVs		All		ZEVs
Mopeds and scooters		Vehicles with first registration of January 1, 2011 or later; ZEVs		ZEVs		Vehicles with first registration of January 1, 2011 or later; ZEVs		ZEVs		Vehicles with first registration of January 1, 2011 or later; ZEVs	ZEVs	

PARIS (FRANCE)

Paris has a LEZ in place and has set a timeline to progressively upgrade it to a ZEZ by 2030.[18] The scheme aims to improve local air quality.

The current LEZ in Paris covers 79 municipalities of the Greater Paris Metropolis that have 5.61 million inhabitants (Figure 9, the City of Paris is in white and other municipalities included are in light blue). It applies to all categories of vehicles. For buses, coaches, and heavy-duty trucks, the scheme operates from 8 am to 8 pm, 7 days a week, and for the other vehicle types, it operates from 8 am to 8 pm on weekdays only. Access to the zone is granted based on the Crit'Air air quality certificate, which is a sticker affixed to the vehicle's windshield.[19] The Crit'Air sticker system divides vehicles into six environmental classes, based on vehicle type, fuel type, and the emission standard to which the vehicle is certified. The most polluting vehicles are not classified and are not entitled to the air quality certificate.

18 Paris City Hall, "Zone à Faibles Emissions [Low Emission Zone]," accessed July 15, 2021, https://www.data.gouv.fr/fr/datasets/zone-a-faibles-emissions-zfe/#:~:text=La%20Ville%20de%20Paris%20a,qualit%C3%A9%20de%20l'air

19 Ministry of Ecological Transition of the French Republic, "Certificats qualité de l'air : Crit'Air [Air quality certificates: Crit'Air]," August 2, 2021, https://www.ecologie.gouv.fr/certificats-qualite-lair-critair

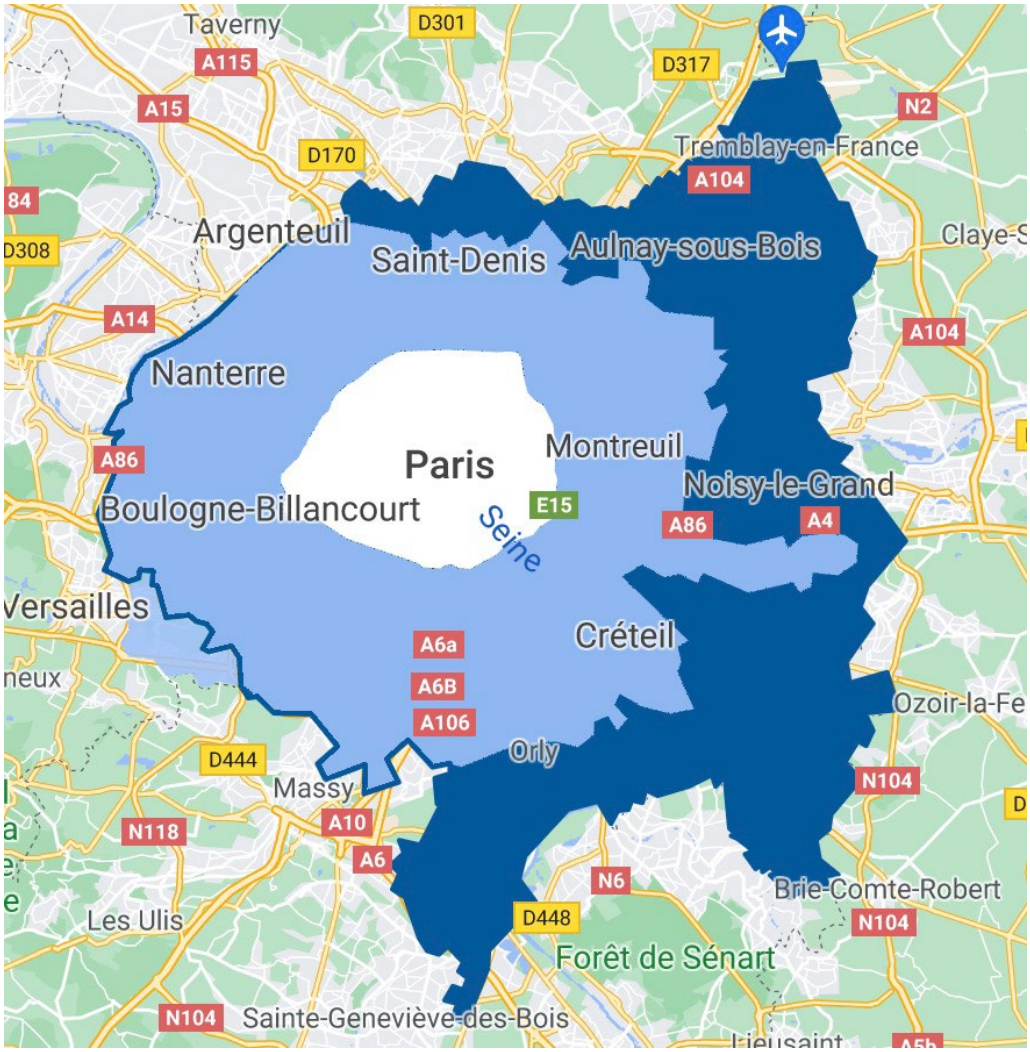


Figure 9. The current LEZ in Paris. *Source:* Google Maps.

Table 3 illustrates the classification of passenger cars under the Crit'Air sticker system and Table 4 shows the progressively tightened emission criteria for the Paris LEZ as it becomes a ZEZ in the coming decade. Enforcement is currently done by the police. There are plans to introduce an automated camera recognition system by July 2022. Non-compliant buses, coaches, and heavy-duty trucks that enter the zone face a penalty of €135 (US$165) and all other types of noncompliant vehicles are charged €68 (US$83). If not paid within 45 days, the penalties increase to €375 (US$459) and €180 (US$220), respectively.

Table 3. Classification of passenger cars under the Crit'Air sticker system in France.

CRIT'Air class	Green	CRIT'Air 1	CRIT'Air 2	CRIT'Air 3	CRIT'Air 4	CRIT'Air 5	Unclassified
Sticker							No sticker
Eligible vehicles	BEVs; FCEVs	PHEVs; Gas-powered vehicles; Euro 5/6 HEVs; Euro 5/6 gasoline vehicles	Euro 4 HEVs; Euro 4 gasoline vehicles; Euro 5/6 diesel vehicles	Euro 2/3 HEVs; Euro 2/3 gasoline vehicles; Euro 4 diesel vehicles	Euro 3 diesel vehicles	Euro 2 diesel vehicles	Euro 1 and earlier gasoline vehicles; Euro 1 and earlier diesel vehicles

Note: BEVs = battery electric vehicles, FCEVs = fuel cell electric vehicles, PHEVs = plug-in hybrid electric vehicles, HEVs = hybrid electric vehicles.

Table 4. Progressively tightened emission criteria for the Paris LEZ as it moves toward a ZEZ.

Effective date	September 1, 2015	July 1, 2016	July 1, 2017	July 1, 2019	June 1, 2021	July 1, 2022	January 1, 2024	2030 goal
Vehicles affected	Buses, coaches, heavy-duty trucks	All vehicles: passenger cars, light-duty vans, two-wheelers, tricycles, quadricycles, buses, coaches, heavy-duty trucks						
Vehicles allowed to enter the City of Paris	Registered on or after October 1, 2001	Green Crit'Air 1 Crit'Air 2 Crit'Air 3 Crit'Air 4 Crit'Air 5	Green Crit'Air 1 Crit'Air 2 Crit'Air 3 Crit'Air 4	Green Crit'Air 1 Crit'Air 2 Crit'Air 3		Green Crit'Air 1 Crit'Air 2	Green Crit'Air 1	Green
Vehicles allowed to enter the other municipalities covered	All			Green Crit'Air 1 Crit'Air 2 Crit'Air 3 Crit'Air 4	Green Crit'Air 1 Crit'Air 2 Crit'Air 3			

LONDON (UNITED KINGDOM)

London plans to implement ZEZs in town centers from 2020 and to expand these to central London from 2025 onward, to a larger area of inner London by 2040, and then to the whole city by 2050.[20] The establishment of ZEZs is considered an essential part of London's transition toward zero-emission road transport and will support the city's goal of becoming a zero-carbon city and having the best air quality of any major world city by 2050.

In September 2019, Transport for London released a *Guidance Note for Local Zero Emission Zones* report to help boroughs of London design and implement ZEZs and near-ZEZs.[21] As introduced above, Hackney and Islington Boroughs and the City of London have each implemented a cross-borough near-ZEZ coving five streets and an 18-month near-ZEZ pilot in Beech Street.

Similar to Amsterdam and Paris, London has a city-wide LEZ in place and it applies to vehicles weighing more than 3.5 tons.[22] In addition, London has a smaller LEZ with stricter emissions criteria that is locally referred to as the Ultra-Low Emission Zone (ULEZ).[23] The ULEZ covers central London and will be expanded to a larger area of inner London, up to the North Circular Road and South Circular Road, beginning on October 25, 2021. This is shown in Figure 10. Both zones operate 24 hours a day, 7 days a week, except Christmas Day for the ULEZ.

20 Mayor of London, *Mayor's Transport Strategy 2018*, (March 2018), https://www.london.gov.uk/what-we-do/transport/our-vision-transport/mayors-transport-strategy-2018

21 Transport for London, "Guidance for Local Zero Emission Zones," accessed July 15, 2021, https://tfl.gov.uk/info-for/boroughs-and-communities/zero-emission-zones

22 Transport for London, "Low Emission Zone," accessed July 15, 2021, https://tfl.gov.uk/modes/driving/low-emission-zone

23 Transport for London, "Ultra Low Emission Zone," accessed July 15, 2021, https://tfl.gov.uk/modes/driving/ultra-low-emission-zone

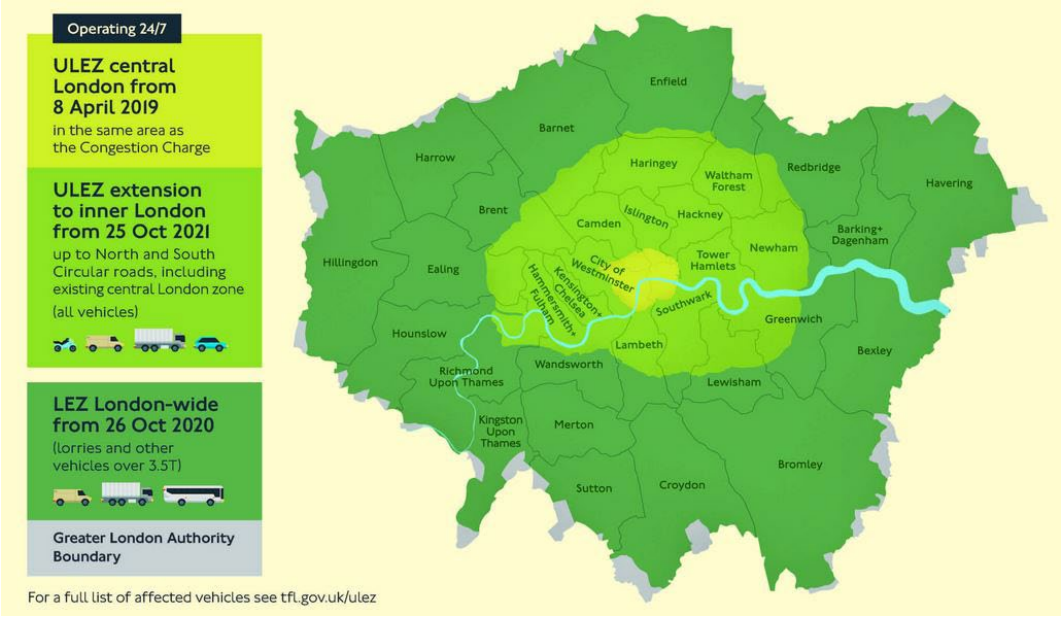


Figure 10. The LEZ and ULEZ in London.

Different from the LEZs in Amsterdam and Paris, the LEZ and ULEZ in London are implemented through a road access charging scheme. Only vehicles meeting specific emissions criteria are granted free access to the zones. Table 5 compares the current emissions criteria for the LEZ and ULEZ in London. Vehicles that do not meet the criteria for the LEZ need to pay a daily charge of either £100 or £300 (US$138 or US$414) depending on the vehicle type. For entering the ULEZ, the daily charge is £12.5 (US$17) for cars, smaller vans, motorbikes, and other lighter vehicles and £100 (US$138) for lorries, buses, coaches, and other heavier vehicles. Both zones are enforced by an automated camera recognition system. If the daily charges are not paid on time, penalty charges from £500 (US$690) to £2,000 (US$2,760) apply depending on vehicle category and emission performance for the LEZ. For the ULEZ, the penalty charge is £160 (US$221) for all noncompliant vehicles. If paid within 14 days, the penalty charges in both zones will be halved.

Table 5. Current emission criteria for the LEZ and ULEZ in London.

Vehicle category		Vehicles allowed to enter freely	
		LEZ	ULEZ
Larger vans and minibuses	**Diesel**	Euro 3/4/5/6 vehicles, ZEVs	Euro 6 vehicles, ZEVs
	Gasoline	All	Euro 4/5/6 vehicles, ZEVs
Buses, coaches, lorries and specialist vehicles	**Diesel**	Euro 6 vehicles, ZEVs	
	Gasoline	All	Euro 6 vehicles, ZEVs
Motorcycles, motor tricycles, and quadricycles		All	Euro 3/4/5/6 vehicles, ZEVs
Cars, private hire vehicles and small vans	**Diesel**	All	Euro 6 vehicles, ZEVs
	Gasoline	All	Euro 4/5/6 vehicles, ZEVs

No plans have been announced as of July 2021 to further tighten the emissions criteria for the LEZ and ULEZ in the future. It is not clear whether the planned ZEZs in

London will be established through upgrading the existing LEZ and ULEZ, either, and no detailed scheme proposals for the planned ZEZs have been released as of July 2021. Based on the guidance released by Transport for London, the planned zones in London may start as near-ZEZs and be tightened to ZEZs when ZEVs become more widely available.

BERGEN (NORWAY)

Bergen planned to introduce ZEZ pilots in parts of the city center by 2020, but this is delayed. It also plans to make the entire city center a ZEZ by 2030, and aims to reduce GHG emissions and become a fossil-free city by 2030.[24] As a first step, the local Urban Environment Agency did some investigating regarding where to establish ZEZ pilots and released an evaluation report in February 2020.[25] Bergen is still considering the size and location of the ZEZ pilots.[26] No detailed scheme proposals have been released as of July 2021.

BERLIN (GERMANY)

Berlin is striving to make the current LEZ, which covers an area of about 88 square kilometers in the inner city within the S-Bahn ring, into a ZEZ. The Urban Development Plan for Mobility and Transport from March 2021 states that in the medium-term, combustion engine fossil fuel vehicles should be excluded from this area. A certain date for exclusion has not been specified yet.[27]

COPENHAGEN (DENMARK)

Copenhagen plans to introduce ZEZ pilots beginning in 2023, with the aim of reducing CO_2 emissions and noise and improving local air quality. The ZEZs will also contribute to the achievement of Copenhagen's goal to become a carbon-neutral city by 2025.[28] The municipality plans to launch three ZEZ pilots in parallel, including a central ZEZ covering the Medieval City that affects passenger vehicles, a smaller ZEZ covering areas that have day care institutions and many children that affects all vehicles, and a ZEZ-F covering a larger geographical area that affects delivery vans starting in 2023 and trucks starting in 2025. There are no detailed scheme proposals released as of July 2021.

FOSHAN (CHINA)

Foshan plans to introduce near-ZEZ-F pilots, locally referred to as Green Urban Delivery Demonstration Zones, to promote green freight.[29] The Foshan Transportation Bureau conducted public consultation on the proposal between December 22, 2020 and January 15, 2021. The planned zones will apply to urban delivery trucks and operate every day between 6 am and 10 pm. Only ZEVs and PHEVs will be allowed to drive in

24 City of Bergen, *Green Strategy: Climate and Energy Action Plan for Bergen*, (September 2016), https://mycovenant.eumayors.eu/storage/web/mc_covenant/documents/8/65nOG32AUwcxBnxv2IYXYsYmSQiydgyW.pdf

25 Norwegian Environment Agency, "Nullutslippssone i Bergen – utredning [Zero Emission Zone in Bergen – Investigation]," 2018, https://www.miljodirektoratet.no/myndigheter/klimaarbeid/kutte-utslipp-av-klimagasser/klimasats/2018/nullutslippssone-i-bergen---utredning/#

26 Olav Juven, Sjur Mikal Dolve, and Johanna Hauge, "Får forby fossilbiler - byrådet i Oslo og Bergen jubler [May ban fossil cars – the city council in Oslo and Bergen rejoices]," January 7, 2021, https://www.nrk.no/osloogviken/far-forby-fossilbiler---oslo-og-bergen-jubler-1.15316658

27 Der Regierende Bürgermeister, Senatskanzlei, "Senat beschließt Stadtentwicklungsplan Mobilität und Verkehr 2030 (StEP MoVe) als neues strategisches Gesamtkonzept der Berliner Verkehrspolitik [Senate adopts Urban Development Plan for Mobility and Transport 2030 (StEP MoVe) as a new overall strategic concept for Berlin's transport policy]," March 2, 2021, https://www.berlin.de/rbmskzl/aktuelles/pressemitteilungen/2021/pressemitteilung.1058932.php

28 Svilena Iotkovska, "Copenhagen Will Test Out Zero-Emission Zones from 2023," April 20, 2021, https://www.themayor.eu/en/a/view/copenhagen-will-test-out-zero-emission-zones-from-2023-7728

29 Foshan Transportation Bureau, "佛山市城市绿色货运配送办法（征求意见稿）[Proposal on Foshan Green Urban Delivery Rules]," March 3, 2021, http://jtys.foshan.gov.cn/gkmlpt/content/4/4718/post_4718486.html#367

the zones during those hours. However, the proposal does not specify things like the implementation dates, the areas affected, or methods of enforcement and penalties.

LUOYANG (CHINA)

Luoyang plans to implement a near-ZEZ-F, locally referred to as Road Access Restriction Area for Urban Delivery Trucks, beginning on Aril 30, 2023.[30] The scheme was adopted on April 20, 2021. The planned zone covers the urban center and applies to urban delivery trucks. It operates 24 hours a day, 7 days a week. Only ZEVs and PHEVs are allowed to drive in the zone. However, all urban delivery trucks, including ZEVs and PHEVs, are banned from entering the zone during rush hours (i.e., 7 am – 9 am and 5:30 pm – 7:30 pm), and methods of enforcement and penalties are not specified.

KEVADIA (INDIA)

Kevadia plans to convert the area surrounding the 182-meter tall Statue of Unity to a ZEZ, locally referred to as Electric Vehicles-Only Area, in a phased manner. The scheme was announced on June 6, 2021 by the Statue of Unity Area Development and Tourism Governance Authority.[31] There are no detailed scheme proposals released as of July 2021.

DUTCH CITIES

In June 2019, the Dutch national government set targets in its National Climate Agreement to establish medium-size ZEZ-Fs, where only zero-emission delivery vans and trucks are allowed to drive, in the country's 30 to 40 largest cities by 2025.[32] Municipalities will be responsible for introducing and enforcing the ZEZ-Fs and the Dutch national government will focus on facilitating the cross-border aspects when necessary. Municipalities are required to announce such zones at least 4 years in advance to allow the government and businesses to prepare. As of July 2021, 28 Dutch cities, including Tiburg, Utrecht, Amsterdam, and Rotterdam, have officially announced that they will implement ZEZ-Fs in 2025.[33] For Amsterdam, this goes in line with its above-mentioned plans to progressively upgrade its LEZ to a ZEZ. For Rotterdam, the planned ZEZ-F is expected to be much larger than its existing ZEZ-F covering 's-Gravendijkwal Street only.[34]

C40 CITIES

Thirty-five cities of the C40 network have committed, through the C40 Cities Fossil Fuel Free Streets Declaration, to ensure that a major area of their city will be zero emission by 2030.[35] Establishing ZEZs is one of the pathways to help the cities fulfill the commitment. Eight of above-mentioned cities that have existing or planned ZEZs and near-ZEZs, including Amsterdam, Berlin, Copenhagen, London, Oslo, Oxford, Paris, and Rotterdam, are signatories of the declaration.

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30 Luoyang Public Security Bureau, "关于进一步规范和优化城市物流配送货车通行管理的通告[Notice on Further Normalizing and Optimizing Road Access Management of Urban Delivery Trucks]," April 21, 2021, http://zw.lyd.com.cn/system/2021/04/21/032019328.shtml

31 Ministry of External Affairs, Government of India, "India's First E-Vehicles-Only Area to be Developed in Kevadia, Gujarat," June 7, 2021, https://indbiz.gov.in/indias-first-e-vehicles-only-area-to-be-developed-in-kevadia-gujarat/

32 Government of the Netherlands, *Climate Agreement*, (June 2019), https://www.government.nl/documents/reports/2019/06/28/climate-agreement

33 Government of the Netherlands, "New Agreement on Urban Deliveries Without CO_2 Emission," February 11, 2021, https://www.government.nl/latest/news/2021/02/11/new-agreements-on-urban-deliveries-without-co2-emission

34 City of Rotterdam, *Roadmap ZECL–Moving Toward Zero Emission City Logistics (ZECL) in Rotterdam in 2025*, (June 2019), https://www.rotterdam.nl/wonen-leven/stappenplan-zero-emissie/Roadmap-ZECL.pdf

35 C40 Cities, "Our Commitment to Green and Healthy Streets," https://www.c40.org/other/green-and-healthy-streets

SCHEMES SUMMARY

Table 6 summarizes the implemented and planned ZEZs and near-ZEZs introduced above. Most schemes are or will be implemented through road access restrictions instead of a road access charging scheme. A common practice is to take a phased approach to introduce a pilot program or a small-scale zone first and then gradually expand the scope.

Table 6. Summary of implemented and planned ZEZs and Near-ZEZs globally as of May 2021.

Jurisdiction	Type	Implementation date	Operation scheme	Vehicles affected	Areas affected	Upgraded from existing LEZs or not
Implemented schemes						
London Boroughs of Hackney and Islington	Near-ZEZ	September 2018	Road access restriction	All	Five streets	No
City of London	Near-ZEZ (18-month pilot)	March 2020	Road access restriction	All	One street	No
Rotterdam	ZEZ-F	January 2015	Road access restriction	Heavy-duty trucks > 3.5 tons	One street	No
Shenzhen	ZEZ-F (pilot)	July 2018	Road access restriction	Light-duty trucks<4.5 tons	~ 22 km²	No
Planned schemes						
Oxford	ZEZ (pilot)	Late 2021	Charging scheme	All	Eight streets	No
	ZEZ	Spring 2022			~ 1.6 km²	
Oslo	ZEZ	2022	Road access restriction	Light-duty vehicles	~ 1.3 km²	No
		2023		All		
		2026			~ 13 km²	
Amsterdam	ZEZ	2022	Road access restriction	Buses and coaches	~ 6.5 km²	Yes
		2025		All except passenger cars	~ 70 km²	
		2030		All	City-wide	
Paris	ZEZ	2030	Road access restriction	All	Greater Paris metropolis	Yes
London	ZEZ or Near-ZEZ	From 2020	Unspecified	Unspecified	Town centers	Unspecified
		2025			Central London	
		2040			Inner London	
		2050			City-wide	
Bergen	ZEZ (pilot)	2020 (delayed)	Unspecified	Unspecified	Unspecified	Unspecified
	ZEZ	2030			City center	
Berlin	ZEZ	Unspecified	Unspecified	Unspecified	Urban area within the S-Bahn ring	Yes
Copenhagen	ZEZ (pilot)	2023	Unspecified	Passenger cars	Medieval City	Unspecified
	ZEZ (pilot)	2023		All	Unspecified	
	ZEZ-F (pilot)	2023		Delivery vans	Unspecified	
		2025		Delivery vans and trucks		
Foshan	Near-ZEZ-F	Unspecified	Road access restriction	Urban delivery trucks	Unspecified	No
Luoyang	Near-ZEZ-F	April 2023	Road access restriction	Urban delivery trucks	Urban center	No
Kevadia	ZEZ	Unspecified	Road access restriction	All	Unspecified	No
30–40 Dutch cities	ZEZ-F	2025	Unspecified	Delivery vans and trucks	Unspecified	Unspecified
35 C40 Cities (including 8 cities mentioned above)	Unspecified	2030	Unspecified	Unspecified	Unspecified	Unspecified

LEGAL BASIS

An underlying legal framework is needed to establish these zones. The Transport Act 2000 of the United Kingdom is one such framework, and it empowers local traffic authorities to introduce local charging schemes to achieve local transport objectives.[36] Based on this, the Oxfordshire County Council is developing the ZEZ in Oxford.

The Energy Transition for Green Growth Law of France created a new article in 2015 that empowered local authorities to create restricted traffic zones in city areas to reduce air pollution.[37] The LEZ in Paris was under the name of restricted traffic zone when it was established in 2015. The Mobility Orientation Law of France modified the Green Growth Law in 2019. It says that the establishment of a LEZ is mandatory before December 2020 when air quality standards defined by law are not met. From January 2021, a LEZ needs to be implemented in France within 2 years if air quality standards are exceeded.[38]

The ZEZ-F pilot in Shenzhen was established based on Article 39 of the Road Traffic Safety Law of China, which empowers local public security bureaus to implement road access restrictions on vehicles.[39]

If municipalities do not have the authority to establish these zones, the legal basis needs to be developed first, either at the national or provincial/state levels. There was no legal basis for municipalities in Norway to establish ZEZs when Oslo and Bergen made initial investigations. In 2021, the Norwegian national government announced in its Climate Plan for 2021–2030 that the legal basis in Section 7 of the Road Traffic Act, which authorizes the Ministry of Transport and Communications to prohibit certain groups of vehicles on certain roads,[40] can be leveraged from a climate point of view to introduce pilot ZEZ projects in a few cities.[41] Municipalities could apply to the Norwegian national government for permission to establish ZEZs. Hainan province of China released a proposal titled Motor Vehicle Emission Control Regulations of Hainan Province[42] for public comments on April 8, 2021. If adopted, this article will empower city-level jurisdictions of Hainan province to establish ZEZs.

In addition to enforceable schemes that require legal basis, cities are also experimenting with voluntary ZEZs. For example, Santa Monica, California implemented a voluntary ZEZ-F pilot in February 2021 and it is locally referred to as a Zero Emissions Delivery Zone.[43] Launched by Los Angeles Cleantech Incubator and the City of Santa Monica, it covers an area of 2.5 square kilometers in the commercial activity core of the city. A dozen delivery partners, including Ikea, FoodCycle LA, and Shopify, and several advisory and tech innovators are working together to test new technologies, policies, and business models for zero-emission last mile delivery in the zone. The experiments include smaller delivery vehicles like sidewalk robots

36 The United Kingdom of Great Britain and Northern Ireland, "Transport Act 2000," https://www.legislation.gov.uk/ukpga/2000/38/contents

37 The Paris LEZ was under the name of restricted traffic zone when it came into force in 2015. République Française, "Law 2015-992 of August 17, 2015 on energy transition for green growth," https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000031044385

38 République Française, "Law 2019-1428 of 24 December 2019 on the orientation of mobility," https://www.legifrance.gouv.fr/jorf/article_jo/JORFARTI000039666659

39 People's Republic of China, "中华人民共和国道路交通安全法 [Road Traffic Safety Law of the People's Republic of China]," August 23, 2005, http://www.gov.cn/banshi/2005-08/23/content_25575.htm

40 The Kingdom of Norway, "Lov om vegtrafikk [Road Traffic Act]," https://lovdata.no/dokument/NL/lov/1965-06-18-4

41 Norwegian Ministry of Climate and Environment, "Climate Plan for 2021–2030," https://www.regjeringen.no/no/dokumenter/meld.-st.-13-20202021/id2827405/

42 Ecological Environment Department of Hainan Province, "海南省机动车排气污染防治规定（征求意见稿）[Motor Vehicle Emission Control Regulations of Hainan Province (proposal for public comments)]", http://hnsthb.hainan.gov.cn/hdjl/zjdc/yjzj.html?collectionId=475&siteId=62

43 Los Angeles Cleantech Incubator, "Santa Monica Zero Emissions Delivery Zone Pilot," accessed July 15, 2021, https://laincubator.org/zedz/

and electric scooters and shared electric delivery trucks. There are no restrictions for other vehicle types. Up to 20 curb spots are to be designated as zero-emission vehicle loading zones and all vehicle-related activity in each curb zone is monitored and analyzed to provide real-time parking availability data to ZEZ-F drivers. This voluntary ZEZ-F pilot will run through December 2021. Depending on the outcome and available funding, the zone might be continued or expanded to other parts of the city; however, there are no concrete plans at present.

SUPPORTING MEASURES

The national governments of European countries, China, and the United States have implemented a comprehensive mix of measures including vehicle regulations, fiscal and non-fiscal incentives, charging infrastructure network development, and consumer awareness raising campaigns to stimulate electric vehicle sales.[44] On top of these policy efforts at the national level, cities highlighted in this paper have adopted additional measures to ensure that people who rely on their vehicle for private purposes or business operations are still able to enter the zones without facing undue burdens. Note, additionally, that all of the zones exempt specific types of vehicles, such as emergency service vehicles, military vehicles, and vehicles of disabled people, from the restrictions.

Local measures range from incentives that help to make the switch to electric vehicles to policies that support other modes of transportation such as public transport, cycling, and walking. For example, people living or working in the Paris LEZ benefit from a maximum LEZ subsidy of €1,000 ($1,200) if they buy or lease a new or used ZEV; this is in addition to the other purchase incentives for electric vehicles provided by the city and the French national government.[45] In Shenzhen, in addition to the purchase subsidies offered by the national and local governments, battery electric delivery trucks are eligible for a usage subsidy of up to CNY 25,000 (US$3,923) per year for three years.[46] In the Netherlands, the government has secured a fund of €185 million (US$220 million) until 2025 to support businesses that purchase zero-emission delivery trucks, which is related to the planned introduction of ZEZ-Fs in Dutch cities.[47] Several Park and Ride (P+R) transit car parks on the periphery of the city-wide Brussels LEZ are accessible to vehicles that do not meet the emissions criteria; these allow drivers to park their cars safely and reach the city center quickly by public transport.[48] Oxford intends to use the income of the ZEZ pilot to fund supporting schemes, the scale and nature of which will depend on the amount of income raised. Grants for charging infrastructure and ZEVs, walking and cycling schemes, and cargo bike schemes are on the list for further consideration.[49]

44 Hongyang Cui, Dale Hall, and Nic Lutsey, *Update on the Global Transition to Electric vehicles through 2019*, (ICCT: Washington, DC, 2020), https://theicct.org/publications/update-global-ev-transition-2019

45 République Française, "Conversion Bonus: From August 3, 2020 to June 30, 2021 Inclusive," December 8, 2020, https://www.service-public.fr/particuliers/vosdroits/F35354

46 Shenzhen Transportation Bureau, "2020年度深圳市纯电动物流配送车辆运营资助项目申报指南[Guidance on Application for Subsidies for the Operation of Battery Electric Delivery Truck in Shenzhen in 2020]," September 2020, http://jtys.sz.gov.cn/attachment/0/705/705617/8120427.pdf

47 Netherlands Enterprise Agency (RVO), "Subsidy Scheme for Emission-Free Company Cars (SEBA)," April 14, 2021, https://www.rvo.nl/subsidie-en-financieringswijzer/seba

48 City of Brussels, "Low Emission Zone," accessed July 15, 2021, https://www.brussels.be/lez

49 Oxford City Council, "Oxford Zero Emission Zone (ZEZ)," accessed July 15, 2021, https://www.oxford.gov.uk/info/20299/air_quality_projects/1305/oxford_zero_emission_zone_zez

CONCLUSION

This review of implemented and planned ZEZs and near-ZEZs globally as of July 2021 leads us to the following conclusions:

Cities are beginning to move toward ZEZs. Several dozen cities globally, mostly in Europe, have announced plans to establish ZEZs or near-ZEZs in the coming decade. In addition, 35 cities of the C40 network have committed to transforming a major part of their city center to be zero emission by 2030, and establishing ZEZs is one the ways to achieve this commitment. The establishment of ZEZs aims to accelerate the transition to electric vehicles and contribute to the achievement of cities' air quality and GHG emissions reduction goals.

Many cities choose to start with freight when developing ZEZs. Given the great contribution of freight transportation to toxic air pollutants and GHG emissions and its reliance on diesel-powered vehicles, many cities choose to establish ZEZ-Fs before introducing zones affecting all categories of vehicles. Two of the four implemented schemes as of July 2021 are ZEZ-Fs. In addition, a number of cities in the Netherlands, China, and Demark have announced plans to establish ZEZ-Fs or near-ZEZ-Fs in the coming 5 years. The other implemented and planned schemes summarized in this paper also take freight vehicles into consideration, though other vehicle categories are also covered.

ZEZs could either be upgraded from LEZs or established from scratch. For cities that have LEZs in place, mostly European cities, it is practicable to upgrade their existing LEZs to ZEZs by progressively tightening the emissions criteria (e.g., Amsterdam, Paris). However, it is not necessary for cities to have a LEZ before introducing a ZEZ. The experiences of Oxford, Shenzhen, and Rotterdam have shown the feasibility of building up a ZEZ from scratch. Cities need to select the approach that fits their goals and local conditions best. It is also practicable for LEZs and ZEZs to coexist in the same city but affect different vehicle categories or different areas.

A phased approach with pilot programs initiated first is widely adopted to introduce ZEZs. Currently, it is challenging to introduce a large-scale ZEZ affecting all vehicle categories at once. A common practice among leading cities is to take a phased approach and launch a pilot program first; this is usually either small in scale or it only affects certain vehicle categories that are easier to electrify. After the pilot, there can be expansion of the scope in stages. A pilot program will give policymakers useful experiences to inform the implementation of later versions.

A legal basis is fundamental for the introduction of ZEZs. When a city plans to introduce a ZEZ or a variant of a ZEZ, it is critical to identify the national or local legal framework that empowers local authorities to do so. If municipalities do not have the authority to establish ZEZs, the regulatory framework needs to be developed first, at the national and/or state/province levels. Cities may also choose to initiate a voluntary ZEZ first, as Santa Monica has done, before introducing an enforceable one that requires legal basis.

There is a comprehensive set of design elements that need to be covered in ZEZ development plans. The design of the implemented and planned zones covered in this paper varies significantly. Feasibility analysis is critical to help each city determine the best way to design their own ZEZs based on key local conditions such as geographical features, electric vehicle uptake, and the spatial distribution of population, traffic volumes, and vehicle emissions. Supporting measures are needed to help residents and businesses affected make the transition. Additionally, though not examined in detail as part of this paper, stakeholder engagement and public consultation from the initial stages also plays an important role in successful implementation of ZEZs.