

NOVEMBER 2022

CASE STUDIES:

DEPLOYING ZERO-EMISSION VEHICLE INFRASTRUCTURE INNOVATIONS TO ACCELERATE TRANSPORT DECARBONIZATION



Berkeley

Center for Law, Energy
and the Environment
SCHOOL OF LAW



INTRODUCTION

Cars, buses, and trucks produce approximately one-fifth of global greenhouse gas emissions.¹ Although global sales of zero-emission vehicles (ZEV) for passenger cars have increased an average of 50 percent per year since 2015, they still make up a small fraction of overall vehicles on roads today and are not evenly distributed around the globe.² A large portion of consumers and fleet owners are still hesitant or unable to purchase these vehicles, often due to concerns about the lack of available charging and refueling infrastructure. While some nations and subnational jurisdictions may have ambitious ZEV infrastructure plans, deploying innovative demonstration projects and developing supportive policies will be crucial to achieving a successful ZEV transition worldwide.

To help guide investment in charging and refueling infrastructure deployment to spur higher ZEV adoption, the Center for Law, Energy and the Environment (CLEE) at University of California, Berkeley, School of Law, along with the Transport Decarbonisation Alliance (TDA), developed this brief to highlight case studies of successful electric vehicle charging infrastructure deployment around the world. The cases describe how jurisdictions engage in planning and regulatory frameworks to support ZEV adoption and infrastructure. These jurisdictions are adopting innovative models and partnerships to increase ZEV fleet adoption, public and private charging deployment, and public awareness of the reduced total cost of ownership of driving ZEV. The case studies, capture work happening in:

- California, United States
- Rotterdam, Netherlands
- British Columbia, Canada
- Portugal
- Costa Rica
- Ghana

Whether national or subnational, whether at the beginning of their ZEV journey or farther along, the case studies presented here provide an array of lessons learned for other jurisdictions looking to incorporate zero-emission vehicles and the necessary infrastructure.

This brief is a companion to the Zero Emission Vehicles Transition Council (ZEVTC) [white paper](#) assessing electric vehicle charging infrastructure and public investments in decarbonizing transport. Members of the ZEVTC are committed to collectively addressing key challenges in the transition to ZEVs.



CALIFORNIA: PROVIDING MARKET CERTAINTY TO DRIVE PRIVATE INVESTMENT

**THE INNOVATION: BUILDING ON
LEGISLATIVE AND REGULATORY GOALS,
INVESTMENTS, AND POLICY CERTAINTY TO
PROMOTE PRIVATE-SECTOR INVESTMENT**

BACKGROUND

California has adopted a range of ambitious vehicle and fuel policies to meet federal air quality mandates and state climate change targets. This includes federal health-based ambient air quality standards with key dates in 2023 and 2031; a 40 percent reduction in greenhouse gas emissions by 2030, increasing to 80 percent by 2050; and 50 percent reduction in petroleum use by 2030.³ Meeting these goals requires a bold transformation in all sectors, including industrial, residential, and transportation, along with significant contributions from public agencies, private businesses, and individuals.

Mobile sources and the fossil fuels that power them are the largest contributors to California's greenhouse gas emissions, fine particulate matter (PM2.5), and toxic diesel particulate matter, as well as the formation of ozone. They are also responsible for approximately 80 percent of the state's smog-forming nitrogen oxide (NOx) emissions.⁴ Transportation is responsible for roughly 50 percent of greenhouse gas emissions when including emissions from fuel production, as well as more than 95 percent of toxic diesel particulate matter emissions.⁵

To drive the bold transformation required, California government uses three main tools: setting clear targets, investing in advanced technologies needed to meet targets, and driving market certainty through regulatory efforts.

Setting Clear Targets

Over the last decade, several California governors have set clear targets through executive orders, supporting the trajectory needed to meet federal mandates and state legislative goals. In 2013, then-Governor Brown issued Executive Order (EO) B-16-2012 calling for 1.5 million ZEVs on the road by 2025.⁷ In 2018, EO B-48-18 called for expanding private investment in ZEV infrastructure, particularly in low-income and disadvantaged communities. The order also set infrastructure targets for vehicle charging stations and hydrogen fueling stations, along with a goal of 5 million ZEVs on California roads by 2030.⁸ In 2020, Governor Newsom issued an executive order setting clear deadlines for the transition to 100% zero-emission vehicle sales in California (2045 for commercial trucks and 2035 for light-duty vehicles, where feasible).⁹

EVS AND INFRASTRUCTURE DEPLOYMENT IN CALIFORNIA

The California Energy Commission has developed a dashboard to track the installation of EV charging stations and the nonprofit Veloz has developed a tool to track the sales of ZEV in California.⁶

As of April 2022, California has:

- 79,023 total public and shared chargers
- 7,158 Direct Current (DC) fast chargers
- More than 600,000 zero emission vehicles on the road
- More than 16% of all new cars sold were EVs

Additionally, California's 2021-2022 Budget made \$10 billion in commitments to ZEV infrastructure for cars, trucks, and ships, including:

- \$7 billion to support medium- and heavy-duty ZEVs
- \$900 million in rebates for ZEV consumers or manufacturers
- \$870 million for EV and hydrogen refueling infrastructure grants
- \$300 million dedicated for equitable at-home charging

Investing in Advanced Technologies

The government of California has provided funding to incentivize zero-emission vehicle technology deployment and support equitable access. For the past two decades, California has signaled support to the private sector by offering a myriad of incentives to attract private dollars. Funding for clean transportation programs comes through a combination of taxes, fees, settlements, and auction proceeds generated through the state's Cap-and-Trade program.¹⁰ These investments support programs from the demonstration phase through equitable deployment of commercial technologies. They have led to rapid expansion of the availability of zero-emission technologies and paved the way for innovative California Air Resources Board (CARB) regulations such as Advanced Clean Cars and Advanced Clean Trucks (which both require vehicle manufacturers to meet increasing sales targets for ZEV in California).¹¹

Spurred by an unprecedented budget surplus in 2021 and 2022, Governor Newsom and the legislature have appropriated \$10 billion for ZEV, \$7 billion of which is intended to accelerate deployment of medium-duty and heavy-duty vehicles and off-road equipment, as well as the infrastructure to support them.¹² Policymakers are focusing many of these investments in disadvantaged and low-income communities to increase these residents' access to the benefits of clean transportation.

Driving Market Certainty with Regulations

California also has a long and distinctive history of regulating vehicle emissions. In addition to setting fuel standards and fleet rules, California also has unique authority to seek waivers to set emissions standards for mobile sources that go above and beyond federal standards. Once set, other states can adopt the California standards. Three main regulations that have been driving investments in infrastructure include the Low Carbon Fuel Standard, Advanced Clean Cars, and most recently Advanced Clean Trucks.

In 2009, CARB adopted the Low Carbon Fuel Standard, a first-of-its kind, market-based regulation designed to decrease the carbon intensity of California's transportation fuel pool and provide an increasing range of low-carbon and renewable alternatives that reduce petroleum dependency and achieve air quality benefits. Providers of transportation fuels with a carbon intensity below California's annual target, including hydrogen and electricity, generate credits, which can be sold to providers of high-carbon transportation fuel who generate a credit deficit for being more carbon intensive than that target. The LCFS program has generated over \$10 billion in revenue through credit transactions and is estimated to have displaced over 22 billion gallons of petroleum fuel since its inception. Similar programs are in place in Oregon and Washington, and are being considered in New York, Illinois, Minnesota, and New Mexico.

The Advanced Clean Cars regulation combines the control of smog-causing pollutants and greenhouse gas emissions into a single coordinated package of regulations: the Low-Emission Vehicle regulation for criteria and GHG emissions and a technology forcing regulation for ZEV that contributes to both types of

emission reductions. Recently readopted, the ACC regulation now sets standards and ZEV requirements for model years 2026-2035. In driving the deployment of light-duty ZEVs, the regulation is also providing market certainty that the infrastructure is necessary.

In June 2020, California adopted the Advanced Clean Truck regulation, which requires truck manufacturers to meet increasing sale targets of zero-emission trucks in California through 2035.¹³ Since adoption, the states of Massachusetts, New Jersey, New York, Oregon, and Washington – 20 percent of the truck market in the United States – have adopted this regulation, sending a clear, aligned message to the truck industry, EV supply equipment providers, fleet operators, and investors that the future is zero-emission.¹⁴ In addition, the complementary Advanced Clean Fleets regulation that California is now developing would put an end to the sale of internal combustion engine trucks in the state by 2040.¹⁵ By driving the deployment of zero emission trucks, these two regulations create a strong market signal that stakeholders (both public and private) can predict and match with their build-out of charging and refueling infrastructure.

LESSONS LEARNED

- 1. ESTABLISH CLEAR TARGETS.** Strong carbon reduction and ZEV deployment targets from California governors and the state legislature set an overarching roadmap that enabled the development of supporting policies. These targets gave policymakers the mandate to invest in incentive programs and design market forcing regulations that align private and public actors across the supply chain.
- 2. REGULATIONS CAN SEND MARKET SIGNAL FOR PRIVATE INVESTMENT.** Regulating manufacturers and fuel providers has proven an efficient and effective tool for growing the zero-emission market in California and other states that adopt California rules. Together, the Low Carbon Fuel Standard, Advanced Clean Trucks, and the Advanced Clean Cars program create market certainty for a more rapid transition to ZEVs. By setting a timeline for increasing ZEV sales and decreasing fuel carbon intensity, California regulations send the market signal needed for vehicle and equipment manufacturers, infrastructure providers and operators, private investors, and utilities to accelerate investment.

ENERGIIZE COMMERCIAL VEHICLE PROGRAM

After years of individual incentive awards for medium and heavy-duty vehicles, the state created the EnergiIZE Commercial Vehicles (Energy Infrastructure Incentives for Zero-Emission Commercial Vehicles) program.

EnergiIZE is the nation's first commercial vehicle fleet infrastructure project and provides incentives for ZEV infrastructure equipment for medium- and heavy-duty battery electric and hydrogen fuel cell vehicles. The project provides a user-friendly and streamlined process for participation by breaking down infrastructure deployment barriers through targeted incentives and specialized assistance. As of October 2022, up to \$276 million in funding is available statewide for infrastructure projects. Among the targeted sectors are disadvantaged, tribal, and low-income communities, with the goal to reduce barriers to participation by providing greater support and additional time to prepare applications for funding.

ROTTERDAM, NETHERLANDS: DEPLOYING FAST CHARGING FOR LOGISTICS

THE INNOVATION: PUBLIC SUPPORT FOR PRIVATELY
FINANCED HEAVY-DUTY EV CHARGING INFRASTRUCTURE



BACKGROUND

The Netherlands has the largest number of EV charging stations in Europe, with more than 75,000 public charging stations and 200,000 residential chargers.¹⁶ Analysts estimate that the country hosts more than 30 percent of Europe's EV chargers. This progress is the result of coordination between a national strategy and local and regional governments.

In the Netherlands, the Municipality of Rotterdam has taken the lead in installing electric charging infrastructure for trucks and delivery vans, despite private medium- and heavy-duty charging still being in the early stages of development. The Port of Rotterdam is one of the busiest ports in Europe and has seen an increasing amount of logistics movements due to e-commerce growth. Rotterdam has an ambitious 2021-2030 Electric Vehicle Charging Infrastructure Strategy.¹⁷ The municipality adopted a Roadmap for Zero Emission City Logistics in 2019 and a subsequent Joint Covenant for Zero Emission City Logistics in December 2020, which established public and private goals for reducing emissions from goods movement among more than 50 companies.¹⁸ In collaboration with private sector partners, Rotterdam has committed to become a Zero Emission Zone for City Logistics (ZES Zone) in 2025, with the goal of spreading ZES zones to 30 to 40 other municipalities in the coming years.

Rotterdam established the *Ecostars* program to encourage business owners and fleet operators to adopt zero-emission delivery vehicles. As a part of *Ecostars*, municipal employees and private technical experts (known locally as logistics brokers) meet with fleet operators to incorporate ZEV and charging solutions. The brokers provide technical assistance to the business owners and inform them how to qualify for appropriate subsidies. In 2021, *Ecostars* focused on small businesses operating within the ZES zone. In total, more than 170 consultations were conducted in 2021, and the program currently has 557 *Ecostars* members. *Ecostars* uses a rating system to show how far a business owner has progressed towards a sustainable fleet.

ZERO-EMISSIONS ZONES FOSTER INNOVATION FOR PUBLIC-PRIVATE PARTNERSHIPS

Rotterdam partnered with *Leap24*, a new company aiming to build a regional fast charging network for delivery vans. Leap24 officially opened its first fast charging station in Rotterdam with seven fast chargers that are ten times faster than Dutch public street charging stations.¹⁹ The Leap24 model makes their chargers accessible to all drivers. While some conventional fast charging stations are difficult to access for delivery vans and trucks, Leap24 focuses specifically on deploying easily accessible locations for larger vehicles to charge. Rotterdam has also announced a partnership with TotalEnergies to fund up to 30 public fast DC chargers and an entire AC charging network for logistics delivery vans and taxis in the ZES zone.²⁰ The chargers are located around the city and the Port of Rotterdam and vary in charging speed from 50 kW to 300 kW, depending on the location, availability of grid power, and need for charging speed.

LESSONS LEARNED

- 1. JUMPSTART PRIVATE CHARGING INSTALLATIONS THROUGH POLICY FRAMEWORKS.** While Rotterdam has built public fast-charging plazas, the vast majority (approximately 85 percent) of Rotterdam's logistics charging infrastructure will be on privately owned land such as business parks, distribution centers and logistics hubs. As a result, the government developed a strategy to facilitate infrastructure installation in these areas, including financial subsidies, technical support, and grants. In addition, Rotterdam urban planners and electric charging infrastructure companies work together to support grid interconnection and asset planning, underscoring the importance of involving land use planners early in the process.
- 2. PROVIDE TECHNICAL ASSISTANCE TO SUPPORT PRIVATE CHARGER ADOPTION.** Rotterdam officials provide logistics companies with technical assistance when installing electric charging, purchasing ZEV, and offering free trials of electric delivery vans and cargo bikes.²¹ This assistance includes information about grid resources and reliability, infrastructure permitting, and land purchases from government officials. Rotterdam has also enlisted logistics brokers to provide complementary advice on how carriers can integrate ZEV into existing fleets.

BRITISH COLUMBIA, CANADA: CHARGING FOR MULTI-FAMILY RENTAL BUILDINGS

THE INNOVATION: USING FINANCIAL
INCENTIVES TO ACCELERATE PRIVATE
CHARGER INSTALLATIONS IN MULTI-UNIT
DWELLINGS



BACKGROUND

Studies have shown that as much as 85 percent of charging for personal EVs occurs at home.²⁴ However, residents of multi-unit residential buildings do not usually have this access. This gap is often because of a lack of readily available electrical sources or dedicated parking. Deploying charging infrastructure in these multi-unit buildings is therefore essential to helping cities and countries reach their decarbonization goals, advance transportation electrification and reduce long-term greenhouse gas emissions.

The Province of British Columbia and Natural Resources Canada (NRCAN) are helping with affordable deployment of charging infrastructure for homes, businesses, and municipalities through B.C.'s CleanBC Go Electric EV Charger Rebate and Fleets programs.²⁵ The program provides funding for 50-75 percent of eligible purchase and installation costs for EV charging stations, including for multi-unit residential buildings.²⁶ These rebates increase accessibility for EV ready parking spaces capable of Level 2 charging for multi-unit residences.

Similarly, through the CleanBC Go Electric Fleets, fleet operators can get combined rebates from NRCAN and the Province for a Level 2 charging station. NRCAN and the Province will also reimburse Indigenous communities and businesses to purchase and install eligible, new, Level 2 charging equipment. Fleet owners may also access a ZEV fleet advisor and apply for rebates for ZEV fleet assessment, facility assessment, and electrical infrastructure before installing charging stations.²⁷

LESSONS LEARNED

- 1. IMPLEMENT FINANCIAL INCENTIVES THAT ENCOURAGE EV CHARGER INSTALLATIONS IN MULTI-UNIT RESIDENTIAL BUILDINGS.** As lack of readily available charging infrastructure is one of the barriers for EV adoption, offering targeted assistance for electric charger installations for multi-unit residential buildings would have a meaningful effect on purchases in the region. The Province of British Columbia provides rebates for installing EV Ready infrastructure and Level 2 charging stations, which can serve as a good model for other regions for encouraging increased adoption of EVs for residents living in multi-unit residential buildings.

MULTI-FAMILY EV INFRASTRUCTURE IN VANCOUVER

The City of Vancouver supports EV charging in existing multi-unit rental buildings to encourage more residents to switch to EVs. To access this program, owners or building managers of existing rental buildings can apply to have city-owned EV chargers installed in their buildings for use by their tenants, if they meet the eligibility requirements of the program. Through this program, the city pays \$93,000 for the EV infrastructure, and the applicant is required to provide a financial contribution of \$2,000. The city also receives funding from the Province's Clean BC Go Electric EV Charger Rebate program.²² This program provides apartment and condo buildings with rebates not just for the EV chargers, but also for the electrical upgrades needed to make the building EV Ready (a minimum of one EV Ready parking space is required per residential unit).²³ The rebates for electrical upgrades cover a portion of the electrical work needed to provide a parking stall with an energized outlet with a cover that provides a final connection point in an electrical wiring installation capable of providing Level 2 charging.

- 2. ENCOURAGE LOW-INCOME AND HISTORICALLY DISADVANTAGED COMMUNITIES TO USE THE REBATES.** The Province of British Columbia provides additional rebates to Indigenous communities and businesses. The decreased prices for longer-range vehicles, coupled with the availability of first-generation ZEVs on the secondary market have put ZEVs within the reach of buyers who cannot otherwise afford them. This would increase the demand for public chargers, and public charger access disparities are more pronounced in areas with a higher proportion of multi-unit housing, where they are critical for EV operation due to a lower likelihood of residential charger access.²⁸ Therefore, financial assistance for infrastructure deployment would encourage new EV purchases to some degree, particularly in low-income and disadvantaged communities where residents may more often lack access to dedicated parking spots with chargers.



PORTUGAL: DESIGNING A NATIONAL E-MOBILITY HUB TO SUPPORT CHARGING INFRASTRUCTURE

THE INNOVATION: DIGITAL PLATFORM FOR EV CHARGING CONNECTING INFRASTRUCTURE WITH ELECTRICITY SERVICE PROVIDERS



MOBI.E
MObilidade Eléctrica

SB-90028



PONTO DE CARREGAMENTO DE VEÍCULOS ELÉTRICOS

INSTRUÇÕES DE CARREGAMENTO

- 1 - VERIFIQUE AS CONDIÇÕES DE PAGAMENTO**
A falta de utilização do carregador está disponível no Posto de Carregamento.
- 2 - ATIVE POSTO**
Aproxime o cartão de pagamento junto ao leitor de ativação. Será emitido um sinal sonoro e no ecrã aparecerá a mensagem: LIGUE AO VEÍCULO.
- 3 - SELECIONE UMA TOMADA E INICIE O CARREGAMENTO**
Escolha uma tomada disponível e conecte o cabo de carregamento ao veículo e depois à tomada do Posto de Carregamento.
- 4 - AGUARDE PELO CARREGAMENTO DO VEÍCULO**
Será iniciado o carregamento, e o cabo permanecerá bloqueado ao veículo e ao Posto de Carregamento, não sendo possível desconectá-lo. Serão apresentados no ecrã os dados da sessão (potência do carregamento, tempo e energia carregada).
A luz indicativa do estado da tomada ficará na cor azul.
- 5 - ESTADO DO CARREGAMENTO**
A qualquer momento durante o carregamento, se o ecrã estiver em modo de espera, aproxime o cartão de pagamento junto ao leitor de ativação, para visualizar os dados da sessão.
- 6 - FINALIZE O CARREGAMENTO**
Para terminar o estado de carregamento, aproxime novamente o cartão de pagamento junto ao leitor de ativação. Caso o ecrã apresente apenas a informação do estado de carregamento será necessário passar novamente o cartão de pagamento.

Photo Source: MOBI.E Mobilidade Electrica

BACKGROUND

In 2010, Portugal passed a Legal Framework for Electric Mobility to create, implement, develop, and execute an electric mobility program. The framework established a goal of universal and equal access to electric mobility services, set standards for operating electric charging points and the legal structure for issuing charging infrastructure licenses (thus separating the individual charging point operators from the electric mobility service providers), and created an entity responsible for the preparation and implementation of electric mobility.²⁹ That entity, the Office for Electric Mobility in Portugal (*Gabinete para a Mobilidade Eléctrica em Portugal*), is responsible for supporting the transition to EVs.

Leaders of the office then set out to create a platform that would allow disparate charging stations to join a national network, as well as develop a seamless payment system and connect customers to nearby charging locations. Launched in 2015, *MOBI.E* is a state-owned entity that assumes responsibility for all transactions in the public charging network and connects all charge point operators with EV users and electric mobility service providers.³⁰ *MOBI.E* serves as the center for Portugal's transportation electrification efforts, helping municipalities plan where charging infrastructure will go and facilitating that installation by private entities. In addition, *MOBI.E* functions in Portugal's regulated electricity market as the Electric Mobility Management Body (E-Mobility Hub), a clearing house that integrates the financial information and energy flows among all the users and companies involved. This service reduces transaction costs and avoids duplication of systems.

The *MOBI.E* network offers a digital platform that simplifies the interactions between drivers and charge point operators.³¹ Specifically, the *MOBI.E* site allows users to find a charging station, determine what speed of charging is available, and compare the price of charging stations. *MOBI.E*'s system also allows for the integration of new utility models, allowing electricity providers to support grid reliability. For example, the *MOBI.E mobi.data* tool maps charging needs and deployment, so electric utilities and service providers know where to invest in grid upgrades, including smart charging capabilities. *MOBI.E* is an integrated and interoperable network that allows all energy retailers, charging station operators, and vehicle owners to utilize the system, with the mobility service provider charging the user for payments. In addition, the Legal Framework for Electric Mobility requires the system to ensure that every publicly accessible charge point is connected to *MOBI.E*'s network. As a result, all of Portugal's 120,000 EV drivers must be able to charge at any of the 2,841 stations (5,181 charging points) around the county. Drivers can access any charging point in Portugal through a radio-frequency identification (RFID) card or commercially available mobile app, similar to an ATM-like system. Commercial providers then receive the revenue through the eMSP, which distributes it to the operators of the charging stations based on the *MOBI.E* system information and electricity counter data, thus minimizing passthrough costs.³²

MOBI.E provides network access to all new charging installers or companies. By lowering barriers to entry, new startups can join the platform and compete for business. EV drivers in turn can find the most convenient nearby station at the lowest cost and highest power when they need it. Although drivers can

find public charging stations everywhere in Portugal, more stations tend to be clustered in dense urban populations. In response, Portugal recently invested €2 million through *MOBI.E* to add 10 charging hubs that have at least 9 charging stations in low-density areas, with a minimum of one 150 kW charger, three 50kW charging stations, and at least five 22 kW charging stations, as well as a transformer station to allow for simultaneous charging among multiple vehicles. The government will franchise each hub to private operators.³³

LESSONS LEARNED

- 1. CATALYZE PRIVATE INVESTMENT THROUGH REGULATORY POLICY THAT SUPPORTS INFRASTRUCTURE BUILDOUT.** *MOBI.E* has successfully created an open network that facilitates and supports private EV charging infrastructure investment. Portugal is only the fourth country in Europe to have at least one charging point per 100 km of road.³⁴ As other jurisdictions set up the digital networks and platforms for charging infrastructure, policy makers can shape the design of the regulatory structure to limit the need for public financing and provide opportunities for electric utilities, private charging station operators, and local governments to create revenue streams. For countries with limited resources to invest in charging infrastructure, early actions to employ best practices for easy installation, streamlined interconnection with the electrical grid, and seamless integration with the digital network will allow private entities to invest in charging at scale.
- 2. DEVELOP A USER-CENTRIC PLATFORM THAT ELIMINATES THE INCONVENIENCE OF COMPETING CHARGING OPERATORS.** *MOBI.E*'s network allows EV drivers to use one card or their mobile app to access any public charger. Since every charger is integrated into the public network and managed by *MOBI.E*, drivers have confidence that stations are maintained. Having all charge point operators and service providers working through the *MOBI.E* platform also allows for a greater number of partnerships that improve driver experience and enhance market competition. It also allows for possible international expansion as the EV market grows.

COSTA RICA: SCALING ELECTRIC BUS CHARGING INFRASTRUCTURE

THE INNOVATION: BINDING ZEV ADOPTION
GOALS FOR PUBLIC BUS FLEETS SPURS
INFRASTRUCTURE INVESTMENTS



Photo Source: Pablo Cambronero

USO OFICIAL



BACKGROUND

In 2019, Costa Rica became one of the first countries to craft a national decarbonization plan which aims to reach net-zero carbon emissions by 2050.³⁵ Because the country's electrical grid is already powered almost entirely by hydropower and wind energy, EVs are fueled largely by carbon-free resources.³⁶ The country also mandated baseline installation of charging stations at least every 80 kilometers on national roads and every 120 kilometers on county roads.³⁷

Costa Rica also set a goal of having 70 percent of public buses be zero-emission by 2035.³⁸ The 2018 Electric Transport Incentives and Promotion Law (*Ley de Incentivos y promoción para el transporte eléctrico*), requires bus system operators to electrify their fleet by 5 percent every 2 years in order to meet the 2035 and 2050 goals.³⁹ The law also requires that electricity distribution companies to build enough charging infrastructure to cover the main roads in the country, leading to the installation of 65 fast charging centers.⁴⁰ By setting legally binding fleet adoption targets, the country's policymakers are ensuring that EV deployment will match charging infrastructure investment.⁴¹

In support of these ambitious targets, Costa Rica launched a 2018 pilot project to deploy three electric buses in collaboration with the German government. The *MiTransporte* project involved several Costa Rican agencies to demonstrate a pathway for national fleet electrification of public buses, including the Ministry of Environment and Energy and the Costa Rican Institute of Electricity.⁴² *MiTransporte* was enhanced in 2020 by 15 additional electric buses purchased voluntarily by a group of bus operators in the metropolitan area of San José.⁴³

The early success of this pilot suggests that electric bus adoption may be possible in advance of the 2035 and 2050 targets. The electric buses are running national routes and gathering technical information to help demonstrate their benefits. In unveiling its third national bus route in 2022, the national government announced that the electric buses had traveled more than 75,000 kilometers and carried more than 150,000 people to date, displacing more than 60,000 liters of diesel and utilizing more than 30,000 kilowatt hours of clean electricity, which avoided 105 tons of carbon dioxide-equivalent emissions.⁴⁴

LESSONS LEARNED

- 1. SET BINDING INSTALLATION TARGETS FOR CHARGING INFRASTRUCTURE THAT KEEPS PACE WITH EXPECTED ZEV GROWTH.** Costa Rica's charging station installation mandate provides bus operators with confidence that infrastructure will support future ZEV purchases. While private bus operators have been mixed on national efforts to electrify mass transit, installing reliable and accessible government-supported charging stations can relieve their concerns about technology limitations and availability.⁴⁵ Costa Rica's plan to ensure broad geographic coverage of chargers and sufficient power output ahead of new demand also supports greater utilization of the country's renewable energy resources while meeting local travel needs.

- 2. FOCUS ON MUNICIPAL FLEETS TO BUILD PUBLIC CONFIDENCE.** According to the national government directive, public transit agencies in every municipality must consider electric buses to be the first option for their public procurement of new vehicles. Similarly, other jurisdictions looking to launch transportation decarbonization initiatives could start with their public fleets and charging stations at existing publicly owned bus depots, along with educating municipal bus operators about the benefits of zero-emission technologies. The *MiTransporte* pilot provided many lessons for electricity distribution companies, bus operators, charging infrastructure providers, users, and policymakers.

Photo Source: Government of Costa Rica



GHANA: NATIONAL DRIVE ELECTRIC INITIATIVE SPURS PRIVATE CHARGING INVESTMENTS

THE INNOVATION: PUBLIC-PRIVATE
PARTNERSHIPS FOR LIGHT-DUTY EV
CHARGING INFRASTRUCTURE



BACKGROUND

In Ghana, recently expanded hydropower and solar energy installations, due largely to a rush of investment by independent power producers during times of national electricity deficits, has led to significant periods of excess zero-carbon electricity. As a result, Ghana's electricity regulators and grid operators now need EVs to help absorb excess generation capacity. To create sustainable electricity demand, use some of the excess capacity, and reduce emissions, the government embarked on the Drive Electric Initiative in 2019 to introduce EVs in Ghana in line with the following goals:⁴⁶

1. Increase electricity demand sustainably to match supply as a way of partially addressing the excess electricity generation
2. Prevent Ghana from becoming a dumping ground for older internal combustion engine vehicles
3. Usher in green and sustainable technology manufacturing and jobs for the future.

Since the launch of the initiative in 2019, the Ghana Energy Commission and Ministry of Energy have spearheaded public-private partnerships with automakers to support the deployment of EVs and charging infrastructure. Government policies created regulations and enforcement mechanisms to ensure appropriate oversight of the EV transition. For example, the government developed clear charging infrastructure standards that private entities could follow and adopt when installing charging portals and stations. The Energy Commission in turn provided technical assistance to charging infrastructure companies, with one mobility executive hoping to deploy EVs in 2023 stating that "all [of Ghana's] regulatory bodies are being engaged to ensure a smooth take-off."⁴⁷

The Energy Commission's push for the adoption of EVs has given significant traction to the market and encouraged private companies to establish charging stations in the country. As of 2022, Ghana had five public charging stations, three of which are owned and operated by Porsche, one owned and operated by POBAD International in partnership with the Electricity Company. These stations have been installed in locations around the country such as at Kempinski, Palace Mall, Total Liberation Road, and A&C Mall in East Legon.⁴⁸ POBAD has plans to install a total of 200 chargers across southern Ghana.⁴⁹ At least 10 additional companies have contacted the Energy Commission with the intention of building charging stations. Further, private transport and logistics companies have already purchased electric buses and installed private charging either at their business or home.

In parallel with the promotion of charging installation, the government led campaigns to boost awareness of EV in the country. The Energy Commission took the lead by organizing Ghana's first e-mobility conference and exhibition in September 2021, which convened stakeholders to discuss the opportunities and offered EV test drives to educate fleet owners and the general public.⁵⁰ This conference attracted significant attention both within Africa and the global north. Its success, along with the international work and recognitions, led to the International

Energy Agency inviting Ghana to present the initiative at the third EV Pilot City Forum that took place after COP 26 in Dundee.

To further capitalize on the benefits of an expanded EV market, the government is actively recruiting automakers and financiers looking to invest in domestic EV manufacturing and assembly. Both Hyundai and EGLE Motors have begun importing vehicle models into Ghana. An e-mobility company, Solar Taxi, that assembles, sells, and leases electric motorbikes, has plans to move from importing vehicles and open an assembly plant in Ghana where their motorbike can be built domestically. The government has supported Solar Taxi partnerships with e-commerce and delivery companies, such as Jumia and Bolt, who currently use Solar Taxi's electric motorcycles to deliver customer orders. Private investors have taken notice of Ghana's potential and supportive landscape, including investment in Solar Taxi from financiers at Persistent Energy.⁵¹

LESSONS LEARNED

- 1. ORGANIZE A NATIONAL DRIVE ELECTRIC INITIATIVE.** The Drive Electric Initiative aims to increase the demand for EVs in Ghana, and this increase in turn encourages the private sector and car manufacturers to supply EVs and install charging infrastructure across the country. Campaigns like Drive Electric Initiative that focus on public-private partnerships to support the deployment of EVs can be beneficial in other global south countries to accelerate demand for EVs.
- 2. UNDERTAKE A BASELINE STUDY OF EV DEPLOYMENT.** Under the Drive Electric Initiative, Ghana is conducting its first baseline study of the EV landscape, which will collect data to inform a baseline for EV deployment in the country. This study will serve as a point of reference to measure future progress achieved through the campaign. The government will then develop standards and regulations to ensure conformity with international standards and regulations in the EV market, as well as to protect the health and safety of consumers. While the adoption of EVs in Ghana is still in its initial stages, the efforts of the energy commission will eventually pave the way for broad adoption of EVs in the country.

GHANA'S FIRST PUBLIC CHARGING FORUM

To further Ghana's objective of encouraging public and private installation of charging infrastructure, the Energy Commission organized the country's first public charging forum in March 2022 to discuss the technology and business opportunities, as well as encourage collaboration among participants both locally and internationally.⁵² The objective of the forum was to introduce current and potential charging station operators (including traditional gas station operators) to the electric charging market. The forum presented opportunities for collaboration, discussed best practices around the world, analyzed the economic potential of charging station operation, and assessed the crucial role of renewable energy in e-mobility.⁵³



CONCLUSION

These case studies can inspire continued action towards accelerating battery electric and fuel cell vehicle deployment. Reliable, resilient, and affordable charging and refueling infrastructure will support additional zero-emission vehicle market growth and will help build consumer confidence.

For more information, please visit the Transport Decarbonisation Alliance at tda-mobility.org.



ENDNOTES

- 1 International Energy Agency (IEA), Net Zero by 2050 (2021), available at <https://www.iea.org/reports/net-zero-by-2050>.
- 2 Maggie Dennis, World Resources Institute, “Are We on the Brink of an Electric Vehicle Boom? Only with More Action” (blog post) (September 16, 2021), available at <https://www.wri.org/insights/what-project-ed-growth-electric-vehicles-adoption>.
- 3 California Air Resources Board, 2022 State Strategy for the State Implementation Plan (adopted September 2022), available at https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf.
- 4 California Energy Commission, “Transforming Transportation” (webpage), available at <https://www.energy.ca.gov/about/core-responsibility-fact-sheets/transforming-transportation>.
- 5 Id.
- 6 California Energy Commission, “Electric Vehicle Chargers in California” (webpage), available at <https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/electric-vehicle>; see also https://www.veloz.org/wp-content/uploads/2022/10/Q3-2022_Electric-Vehicle-Market-Share-in-California_Final.png.
- 7 State of California, Executive Order B-16-2012, available at <https://www.ca.gov/archive/gov39/2012/03/23/news17472/index.html>.
- 8 State of California, Executive Order EO B-48-18, available at <https://www.ca.gov/archive/gov39/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/index.html>.
- 9 State of California, Executive Order N-79-20, available at <https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf>.
- 10 See generally California Assembly Bill 118 (Núñez, 2007), Assembly Bill 32 (Pavley, 2006), Assembly Bill 8 (Perea, 2013), Assembly Bill 1550 (Gomez, 2016).
- 11 California Air Resources Board, Advanced Clean Fleet Regulation: Initial Statement of Reasons (2022), available at <https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/acf22/isor2.pdf>.
- 12 State of California, “Governor Newsom Signs Budget Putting Money Back in Californians’ Pockets and Investing in State’s Future” (press release) (June 30, 2022), available at <https://www.gov.ca.gov/2022/06/30/governor-newsom-signs-budget-putting-money-back-in-californians-pockets-and-investing-in-states-future/>.
- 13 For more information about the California Air Resources Board Advanced Clean Trucks regulation (adopted June 2020), visit <https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks>.
- 14 Kate Magill, “Nearly 20 states push ahead with truck electrification plan” Transport Dive (July 28, 2022), available at <https://www.transportdive.com/news/interstate-coalition-releases-electric-truck-adoption-action-plan/628326/>.
- 15 For more information about the California Air Resources Board Advanced Clean Fleets regulation, visit <https://ww2.arb.ca.gov/our-work/programs/advanced-clean-fleets>.
- 16 Joshua Hill, “Netherlands targets 70% EVs on smart chargers by 2025” The Driven (February 17, 2022), available at <https://thedriven.io/2022/02/17/netherlands-targets-70-evs-on-smart-chargers-by-2025/>. see also AFP, “Netherlands has the largest number of EV charging stations in Europe” (August 2021), available at <https://www.dailysabah.com/life/environment/netherlands-has-the-largest-number-of-ev-charging-stations-in-europe>.
- 17 Rotterdam Charging Infrastructure 2021-2030 Strategy, https://www.rotterdam.nl/wonen-leven/nul-emissie-mobiliteit/Laadstrategie-Rotterdam_ENG.pdf
- 18 Municipality of Rotterdam, “Covenant ZECL towards Zero Emission City Logistics Rotterdam” (December 2020), available at <https://www.rotterdam.nl/wonen-leven/zero-emissie-stadslogistiek/Covenant-Zero-Emission-City-Logistics-Rotterdam.pdf>; see also “Roadmap ZECL: Moving towards Zero Emission City Logistics (ZECL) in Rotterdam in 2025” (June 2019), available at <https://www.rotterdam.nl/wonen-leven/stappenplan-zero-emissie/Roadmap-ZE-CL.pdf>.
- 19 Petrol Plaza, “LEAP24 opens fast charging station for delivery trucks in Rotterdam” (September 14, 2022), available at <https://www.petrolplaza.com/news/30876>.
- 20 Total Energies, “Climate and Sustainability” (webpage), available at <https://totalenergies.com/sustainability/climate-and-sustainability-energy/climate-change-related-challenges>.

- 21 CE-Delft, “Charging infrastructure for electric vehicles in city logistics” (April 2021), available at https://cedelft.eu/wp-content/uploads/sites/2/2021/04/CE_Delft_4T28_Charging_infrastructure_ev_FINAL.pdf.
- 22 British Columbia Hydro (BC Hydro), “CleanBC - Go Electric EV Charger Rebate Program” (webpage), available at <https://www.bchydro.com/content/dam/BCHydro/customer-portal/documents/power-smart/electric-vehicles/EV-incentive-program-guide.pdf>.
- 23 Id.
- 24 U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, “Charging at Home,” (webpage) 2018, available at <https://www.energy.gov/eere/electricvehicles/charging-home>.
- 25 Province of British Columbia, “CleanBC Go Electric Fleets Program” (webpage), available at <https://plug-inbc.ca/go-electric-fleets/>.
- 26 Id.
- 27 PlugIn BC, “Increased rebates for home, workplace, and fleet charging stations in B.C.” (webpage), available at <https://pluginbc.ca/increased-rebates-for-home-workplace-and-fleet-charging-stations-in-b-c/>.
- 28 CW Hsu, “Disparities in public charging infrastructure deployment and inequitable electric vehicle ownership cost based on income and race” (December 2019), available at https://www.researchgate.net/publication/337971684_Disparities_in_public_charging_infrastructure_deployment_and_inequitable_electric_vehicle_ownership_cost_based_on_income_and_race.
- 29 Portugal Legal Framework for Electric Mobility (2010), available at <https://climate-laws.org/geographies/portugal/policies/decreed-law-39-2010-on-electric-mobility-last-amended-by-decreed-law-90-2014>.
- 30 For more information about MOBI.E Corporate Governance and Structure, visit: <https://www.mobie.pt/quemsomos/relat%C3%B3rios-de-governo-societ%C3%A1rio>.
- 31 Energy Cities, “MOBI.E – E-Mobility Network” (blog post), available at <https://energy-cities.eu/best-practice/mobie-e-e-mobility-network/>.
- 32 Diogo Beirão, “Good Practices: MOBI.E Portuguese Electric Mobility Network” (blog post) Interreg Europe (May 2020), available at <https://www.interregeurope.eu/good-practices/mobie-portuguese-electric-mobility-network>.
- 33 Ambiente Magazine, “MOBI.E Opens This Tuesday Charging Hub In Loulé” (September 2022), available <https://www.ambientemagazine.com/mobie-e-inaugura-esta-terca-feira-hub-de-carregamento-em-loule/>.
- 34 European Automobile Manufacturers Association, Making the Transition to Zero-Emission Mobility 2022 Progress Report (2022), available at https://www.acea.auto/files/ACEA_progress_report_2022.pdf.
- 35 Costa Rica Decarbonization Plan, Commitment of the Bicentennial Government, available at <https://2050pathways.org/wp-content/uploads/2019/02/Decarbonization-Plan-Costa-Rica.pdf>.
- 36 Costa Rican Institute of Electricity, 2020 Fascículo Electricidad (2021), available at https://www.grupoice.com/wps/wcm/connect/579dfc1f-5156-41e0-807d-d6808f65d718/Fasciculo_Electricidad_2020_ingles_compressed.pdf?MOD=AJPERES&CVID=m.pGzcp.
- 37 Sumati Kohli, et al., Zero-emission vehicle deployment: Latin America ICCT - International Council on Clean Transportation (April 2022), available at <https://theicct.org/wp-content/uploads/2022/04/EMDE-Latin-America-briefing-A4-v2.pdf>.
- 38 Samantha Schmidt, “Costa Rica’s environmental minister wants to build a green economy. She just needs time” Washington Post (August 31, 2021), available at <https://www.washingtonpost.com/climate-solutions/interactive/2021/costa-rica-andrea-meza-climate-change/>.
- 39 La Asamblea Legislativa De La República De Costa Rica, “Ley 9518: Incentives - Law and promotion for electric transportation” (2018), available at http://www.pgrweb.go.cr/scij/Busqueda/Normativa/Normas/nrm_texto_completo.aspx?param1=NRTC&nValor1=1&nValor2=85810&nValor3=111104&strTipM=TC.
- 40 The Climate Group, “Costa Rica Taking Action on ZEV Deployment” (fact sheet), available at <https://www.theclimategroup.org/sites/default/files/2022-03/Climate%20Group%2021587%20-%20Under2%20-%20ZEV%20Community%20Project%20-%20Regional%20Profiles%20-%20Costa%20Rica%20AW.pdf>.
- 41 United Nations, “Costa Rica Commits to Fully Decarbonize by 2050” (March 4, 2019), available at <https://unfccc.int/news/costa-rica-commits-to-fully-decarbonize-by-2050>.
- 42 Daniela Álvarez Keller, et al. Buses eléctricos para Costa Rica: Aprendizajes de un proyecto piloto y recomendaciones para el escalamiento (2021), available at https://changing-transport.org/wp-content/uploads/2022_Buses_electricos_para_Costa_Rica.pdf.
- 43 GIZ, “MiTransporte” (fact sheet), available at https://www.giz.de/en/downloads/giz2019_en_Factsheet_Mi-Transporte.pdf.
- 44 BNAméricas, “Third electric bus route operates from April 1 in Costa Rica” (press release) (March 28, 2022), available at <https://www.bnamericas.com/en/news/third-electric-bus-route-operates-from-april-1-in-costa-rica>.

- 45 Somini Sengupta, "Trams, Cable Cars, Electric Ferries: How Cities Are Rethinking Transit" New York Times (October 3, 2021), available at <https://www.nytimes.com/2021/10/03/climate/cities-public-transit-electric-tram-ferry-bus-cable-car.html>.
- 46 For more information about the Ghana Energy Commission's Drive Electric Initiative, visit <https://www.energycom.gov.gh/efficiency/drive-electric-initiative>.
- 47 Joy Business, "Ghana to begin manufacturing of electric vehicles from 2023" (March 21, 2022), available at <https://www.myjoyonline.com/ghana-to-begin-manufacturing-of-electric-vehicles-from-2023/>.
- 48 Ghana Energy Commission, 'Public Charging Stations', available at <http://www.energycom.gov.gh/efficiency/drive-electric-initiative/public-charging-stations>; and CNR, 'TotalEnergies Ghana opens first electric vehicle charging station in Accra', available at <https://citinewsroom.com/2022/09/totalenergies-ghana-opens-first-electric-vehicle-charging-station-in-accra/>.
- 49 CleanTechnica, "The Electricity Company of Ghana & POBAD International Partner to Install EV Charging Stations In Ghana" (December 8, 2020), available at <https://cleantechnica.com/2020/12/08/the-electricity-company-of-ghana-pobad-international-partner-to-install-ev-charging-stations-in-ghana/>.
- 50 Clean Technica, 'Ghana Holds Its 1st E-Mobility Conference & Exhibition Under the Drive Electric Initiative' (2021), available at <https://cleantechnica.com/2021/09/30/ghana-held-its-1st-e-mobility-conference-exhibition-under-the-drive-electric-initiative/>.
- 51 Persistent Energy, "Persistent's e-mobility venture building expands to West Africa with Solar Taxi partnership" (press release) July 4, 2022, available at <https://persistent.energy/news/persistents-e-mobility-venture-building-expands-to-west-africa-with-solar-taxi-partnership/>.
- 52 Ghana News Agency, 'More than 1000 electric vehicles operating in Ghana', available at <https://www.gna.org.gh/1.21442505>.
- 53 For more information about the Ghana Energy Commission Drive Electric Initiative Forum, visit <http://www.energycom.gov.gh/efficiency/drive-electric-initiative/gallery>.

ABOUT THE CENTER FOR LAW, ENERGY & THE ENVIRONMENT

The Center for Law, Energy & the Environment (CLEE) channels the expertise and creativity of the Berkeley Law community into pragmatic policy solutions to environmental and energy challenges. CLEE works with government, business, and the nonprofit sector to help solve urgent problems requiring innovative, often interdisciplinary approaches. Drawing on the combined expertise of faculty, staff, and students across the University of California, Berkeley, CLEE strives to translate empirical findings into smart public policy solutions to better environmental and energy governance systems.

ABOUT THE TRANSPORT DECARBONISATION ALLIANCE

The TDA is a unique collaboration among countries, cities, regions and companies to accelerate the worldwide transformation of the transport sector towards a net-zero emission mobility system before 2050. Established in 2018, the TDA fosters cooperation among participants toward carbon-free transport, accelerating action through synergy. In the TDA, countries, cities, regions and companies work with each other and an ecosystem of partners to create pathways to decarbonise transport as quickly as possible.

AUTHORS

Ross Zelen

CLIMATE CHANGE RESEARCH FELLOW
CENTER FOR LAW, ENERGY & THE
ENVIRONMENT

Ethan Elkind

DIRECTOR - CLIMATE PROGRAM
CENTER FOR LAW, ENERGY & THE
ENVIRONMENT

Shruti Sarode

CLIMATE CHANGE RESEARCH FELLOW
CENTER FOR LAW, ENERGY & THE
ENVIRONMENT

ACKNOWLEDGEMENTS

The authors thank the many contributing organizations:

- California Air Resources Board
- California Energy Commission
- Municipality of Rotterdam
- Province of British Columbia, Canada
- Portugal Office for Electric Mobility (Gabinete para a Mobilidade Eléctrica em Portugal)
- Ghana Drive Electric Initiative

DESIGN

Document design and layout:
Odd Moxie

Image credits unless noted:
Adobe Stock

Berkeley

Center for Law, Energy
and the Environment
SCHOOL OF LAW



TRANSPORT
DECARBONISATION
ALLIANCE

Center for Law, Energy & the Environment
University of California
Berkeley School of Law
Suite 460, 1995 University Avenue
Berkeley, California 94704

clee.berkeley.edu