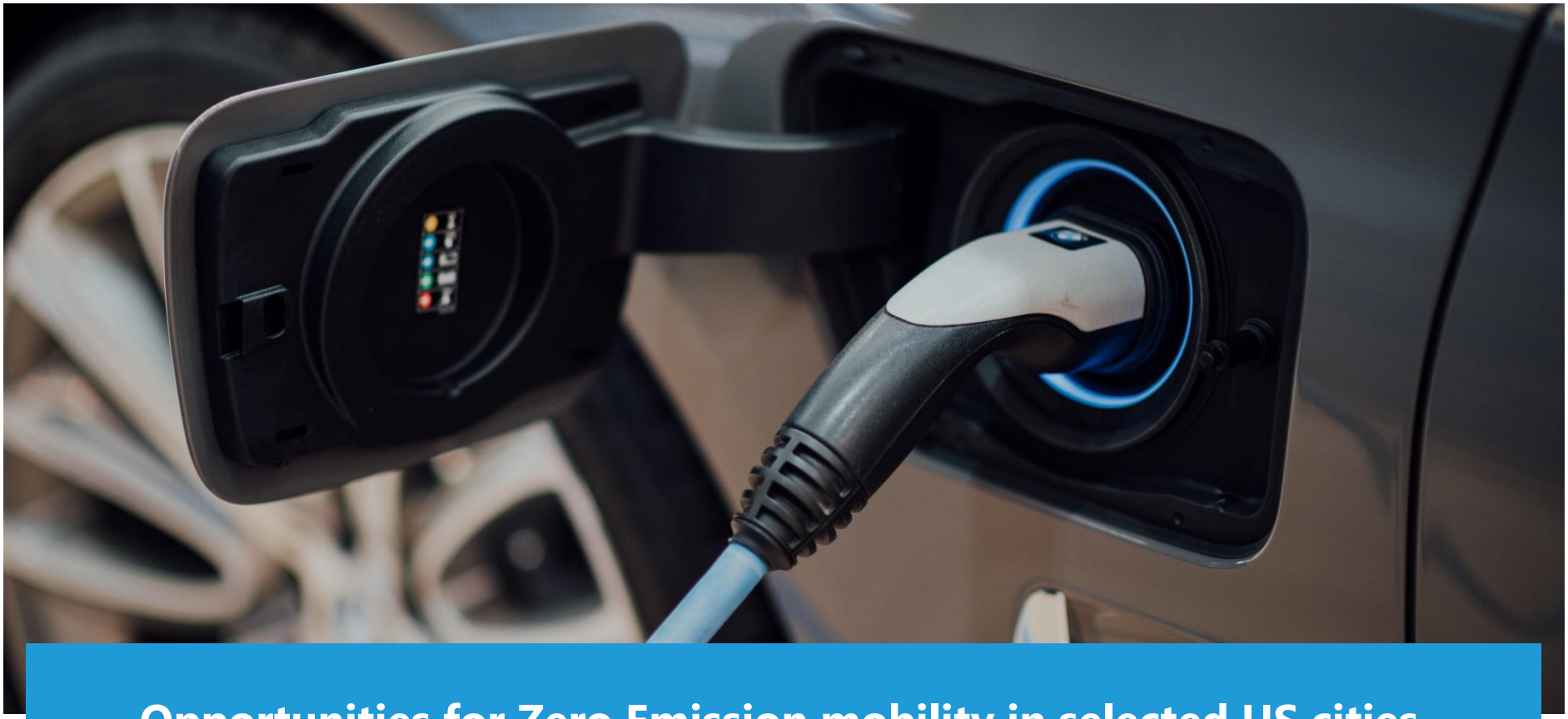
Ministry of Foreign Affairs

Opportunities for Zero Emission mobility in selected US cities

Commissioned by the Netherlands Enterprise Agency

>> *Sustainable. Agricultural. Innovative. International.*



Opportunities for Zero Emission mobility in selected US cities

For Dutch companies and organisations that aim to extend their activities to the Californian E-mobility market

Version 1.0 | November 2020

Arpm
management consultants

MANAGEMENT SUMMARY

California and the West Coast of the United States is one of the most important areas in the world for electrification of mobility. Not only will the region serve as an example for the United States, but its role as international technology hub will enable unparalleled partnerships between private and public sectors. In this report, a combination of research, experience, and interviews with experts from across the coast have revealed the challenges and opportunities this region faces. Four cities in particular, Los Angeles (CA), San Francisco (CA), Sacramento (CA), and Portland (Oregon) demonstrate the challenges that municipalities, governments, and communities face in electrifying transport. The first two chapters outline their characteristics and ambitions, as well as the progress they have made so far in achieving those goals.

The third chapter focuses on the challenges in upscaling charging infrastructure. Strategies, though coordinated separately at the state, regional, and local levels, have coalesced around building out more public DC fast charger networks and level two home charging. This reality reflects the difficulty in getting home charging for many Americans, particularly those in multi-unit dwellings (MUDs); they over rely on DC fast chargers as a result. A change to one may help the other, as would companies that can successfully alter consumer behavior to rely on low intensity charging.

Chapter four talks about vehicle-to-grid-integration (VGI) and the potential for grid management to save millions in energy costs. The VGI space is presently in the earliest development stages; the tradeoffs vehicle telematics and networked charging both offer make it an undecided market. Benefits are further hampered by an aging grid infrastructure that needs help.

The final investigative chapter details the efforts to electrify fleets by both the public and private sectors. Both government and private fleets of every size have seen the fiscal benefits of electrification, but they face challenges in accessing charging or fully utilizing every market pathway (such as VGI and grid resilience applications).

The final three paragraphs house conclusions, recommendations, and opportunities for Dutch businesses working in the EV marketplace. At the highest level, they recommend targeting the underserved areas of the California and Oregon markets, such as MUD charging, and focusing on delivering a full suite of charging management services. They also recommend leveraging partnerships with governmental and businesses for demos and pilots for developing technologies. A few concrete steps and ways to get started in California are provided.

The appendices contain information on stakeholder definitions, how a charger gets put into the ground, and useful links for grant and connection purposes.

TABLE OF CONTENT

1. Background and purpose

In the past years, within the Partners for International Business (PiB) S4C Smart e-Mobility (also called Coast-to-Coast program), Dutch organizations in the field of zero emission and smart mobility have been working to enter the California and American markets. Several Dutch organizations have started doing business in California, and they have already invested in a local network. Trade relations were established, and several companies have set up offices in the US.

The Coast-to-Coast program has worked to identify and analyze opportunities for smart and clean transportation solutions in the US as well as overseas. As closing part of this program with the Dutch Government for the past eight years, APPM was asked to conduct a Market Study to better understand the opportunities moving forward. This document contains the results of the Market Study based on desk research and field interviews with US stakeholders in both California and Portland (Oregon).

1.1 Purpose of this study

California has ambitious policy and zero emission transportation goals as well as investments and innovation; Governor Gavin Newsom's recent executive order that all new vehicles should be emission free by 2035 highlights these ambitions. This opens up business opportunities for Dutch organizations that are already market leaders through their products and services for electric vehicles (EV). These organizations understandably aim to extend their activities to the promising Californian market. To support those organizations, concrete insights into how possible projects and partnerships come about is very important.

The purpose of this Market Study is **to provide insight into the Californian EV-market** to support Dutch companies aiming to expand there. Concrete business opportunities for Dutch companies will be addressed and recommendations on how to act will be provided. The recent COVID19 situation could impact goals, policies and investments which cannot be overseen yet. Where information is available on this topic this will be addressed.

The Coast-to-Coast Smart e-mobility (S4C) program

Both the European and the US West-Coasts are pioneering in smart e-mobility. The two regions have a lot in common, facing many of the same challenges and generating similar business opportunities. The S4C Smart e-Mobility Program (2012-2020) is a public-private partnership designed to promote knowledge and innovation exchange between US and Dutch governments and universities. It contributes to positioning companies in the respective e-mobility markets. You can find more information about the partnership on the Coast to Coast website (https://coast2coastev.org/).

In the eight year duration of the S4C program, many networking moments, trade missions and projects were organized. Just in 2019, five trade missions took place, at least four congresses were organized and attended, and several projects have been set up, including the Smart Charging Living Lab in UCDavis and projects for EVBox and Itility. This contributes to the exposition of products and services of the partners, B2B, networking and knowledge gathering and exchange. The program ended in October 2020. The large group of partners (25 Dutch and 10 from the US) will continue to work on mutual benefits and projects on smart e-mobility.

1.2 Research set-up

In this report, we have combined research, experience, and interviews with experts from across the coast to identify the challenges and opportunities the Californian EV-market faces. This was guided by a brief survey sent out to Coast-to-Coast participants to ensure this Market Study meets their expectations and needs. Results confirmed that relevant themes to investigate included EV policy, deployment of charging infrastructure, developments in VGI, heavy duty electrification, and public transport. These themes comprise the core business of several Dutch organizations in the EV space. By studying the state of play in

California, we aim to match the expertise, products, and services of Dutch companies with potential openings in the Californian market.

1.3 Report outline

This report presents the results of the Market Study in several chapters. **Chapter 2** explains the current policies on EVs in California and selected cities (San Francisco, Los Angeles, and Sacramento in California, alongside Portland in Oregon). These cities are selected based on their high reputations for electrification and climate conscious policies – this makes them the most attractive markets for European parties. **Chapter 3** investigates the challenges in upscaling charging infrastructure across the US market. **Chapter 4** explains possibilities in Vehicle Grid Integration (Smart Charging), and **Chapter 5** talks about electrifying different fleets. The report concludes with our conclusions (**Chapter 6**), recommendations (**Chapter 7**), and some tips & tricks to consider when expanding into North America (**Chapter 8**).

2. High EV ambitions in California and selected cities

California, long a pioneer in the technology and mobility domain, has some of the most ambitious electrification goals in the world; it certainly has the most ambitious in the United States. Leveraging its immense economy and nearly 40 million people, statewide regulatory efforts, incentive programs, and flexible policies will undoubtedly set the stage for the nation. At the heart of those efforts is the electrification of its metro-areas: Los Angeles, San Francisco, and Sacramento. Not to be left out, Portland and the Pacific Northwest (the states of Oregon and Washington) are also forging electric futures. This chapter outlines these areas' goals, timelines, and policies so one can see where the West Coast is going and where one's business fits in the puzzle of electrification.

2.1 State of California

General information

California is ten times larger than the Netherlands with an area of more than 430,000 km2 and a population of more than 39 million inhabitants (see Table 1). This makes California the third largest state in the US and by far the most populous. The state is home to eight of the 50 largest cities in the country. Los Angeles is the second largest city in the United States with about 3.98 million inhabitants (see table 1). With a GDP of US$ 2.9 trillion (14% of the US total), California is also the largest US state in economic terms. California alone generates more than Great Britain.[1]

In California, the car is the main means of transportation and for many residents there is no alternative. Public transportation is less commonly used than in Europe.

[1] https://data.ca.gov/group/economy-and-demographics; www.ca.gov

EV policies

The transportation sector in California is responsible for more than half of the state's CO2 emissions. Therefore, California implemented a unique combination of laws, incentives, regulations, and funding opportunities to grow sustainable mobility. The **California Air Resources Board (CARB)** is now drawing up regulations based on the decree of Governor Gavin Newsom for a ban on new vehicles with combustion engines from 2035. Altogether, this led to a much faster uptake of electric vehicles than elsewhere in the United States and most other places around the world.[2]

The state has spurred EV adoption for years with political measures. California imposed quotas for electric cars on the auto industry. These quotas, laid down in the so-called ZEV mandate (where ZEV stands for "**Zero Emission Vehicle**"), are based on an exemption regulation. The ZEV program is part of the California Air Resources Board's (CARB) Advanced Clean Cars package of coordinated standards that control smog-causing pollutants and greenhouse gas emissions of passenger vehicles in California (please refer to the appendix for further information on California's government bodies).[3]

Meanwhile, California and CARB are also putting pressure on the commercial vehicle sector, requiring manufacturers to sell an increasing proportion of electrically powered trucks, vans, and pickup trucks from 2024 onwards. The current regulation will gradually increase towards about 60% by 2035[4]. By 2045,

[2] https://businessportal.ca.gov/zero-emission-vehicle-program/path-to-2030/

[3] https://www.energy.ca.gov/data-reports/energy-insights/zero-emission-vehicle-and-charger-statistics

[4] https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks

every new commercial vehicle in California is to be electric. The state announced these plans at the end of June of this year. In the public transportation sector, there is already a regulation that all Californian transportation companies will be allowed to buy only fully electric buses from 2029 onwards.[5]

The **ZEV regulation** is designed to achieve the state's emission reduction goals by requiring car manufacturers to sell specific numbers of zero emission vehicles. Currently twelve states have adopted California's ZEV regulations, as well as low-emission vehicle regulations, and multiple other states are expected to join in the near future. Together with California, these states represent around 30% of new car sales in the United States.

In 2020 the new program **Charge Ready 2** was launched; California Public Utilities Commission gave approval for the largest utilities in California, such as Southern California Edison (SCE), to start installing 38,000 new electric car charging stations over the next five years. The program also sets a target to locate 50% of the chargers in state-designated disadvantaged communities, defined as those economically impacted communities that suffer most from the effects of air pollution.[6]

Increasingly the federal states, for example New York, introduce regulations to promote electromobility based on the Californian example. This leads to increased pressure on the **national government**. It is expected that the nation's new president, Joe Biden, will give a much larger role to electric mobility and environmental protection than Trump, who has been fighting subsidies and tax benefits for electric vehicles. It remains to be seen to what extent Biden will be able to appoint far-reaching decrees here. This depends largely on which political party holds a majority in the Senate.[7]

Currently, electric cars are being financially promoted nationwide by a tax rebate of up to 7,500 dollars. In California, there is also a rebate of between 1,000 and 4,500 dollars from the California Clean Vehicle Rebate Project (CVRP) and a further 2,500 dollars for low-income households.[8]

The timeline on the next page shows the goals and ambitions of California up to the year 2050 and puts them in connection with the Dutch. Table 1 below shows figures for California, the US and the Netherlands.

Table 1 Facts and figures on the infrastructure for electric transport and charging [9]

	California	US	Netherlands
Population	39.51 Mio.	330.26 Mio.	17.28 Mio.
Area in km2	432,970	9,834,000	41,543
Number of registered passenger cars	26.3 Mio.	273 Mio.	8.5 Mio.
Number of fully electric and plug-in hybrid cars	763,816 (2.9%)	1,697,369 (0.6%)	250,840 (3%), of which 144,876 fully electric
(Semi)public charging points	67,343	106,906	58,388

[5] https://business.ca.gov/industries/zero-emission-vehicles/zev-action-plan/

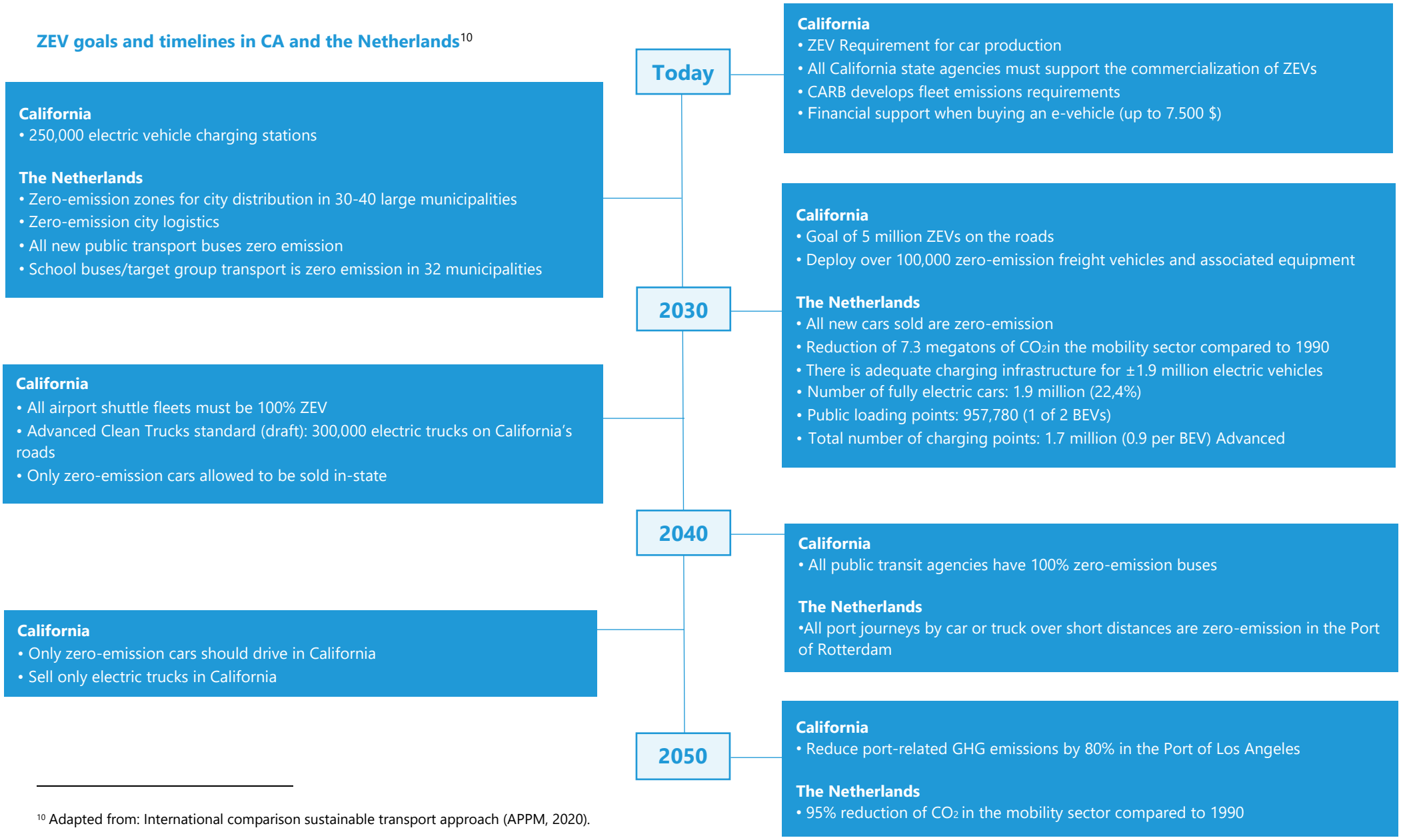
[6] https://electricenergyonline.com/article/energy/category/ev-storage/143/851704/california-public-utilities-commissioncpuc-expands-sce-charge-ready-2-transportation-electrification-program.html

[7] https://cleantechnica.com/2020/11/04/how-the-us-election-could-impact-the-ev-industry/ ; https://cleantechnica.com/2020/11/01/joseph-biden-aims-to-improve-us-ev-tax-credit-restore-it-for-tesla-gm/ ; /www.utilitydive.com/news/biden-outlines-2t-plan-to-invest-in-renewables-electrification/581637/

[8] https://sfenvironment.org/buy-electric

[9] www.kba.de/DE/Statistik/Fahrzeuge/Bestand/bestand_node.html; Zahlen Elektrisches Fahren, RVO (2019); United States Census Bureau 2020 (www.census.gov); https://afdc.energy.gov/stations/states; Veloz.org, RVO.nl, https://www.dmv.ca.gov/portal/uploads/2020/06/2019-Estimated-Vehicles-Registered-by-County-1.pdf

ZEV goals and timelines in CA and the Netherlands[10]



[10] Adapted from: International comparison sustainable transport approach (APPM, 2020).

Current status of the EV market

California's policy and regulatory pressures have led to an increase in electromobility and the growth of the entire sustainable mobility sector. There are currently over 763,000 EVs on the road in California. This represents 2.9% of all cars in the state. This is about three times as many absolute e-vehicles as in the Netherlands, but the ratio of EVs to the total of passenger cars is almost the same in both areas (2.9 vs 3%). Meanwhile, EV sales figures in California have been developing steadily over the past years. In 2016, the number of e-vehicles sold was 72,683, in 2017 93,587 and in 2019 147,347, which is about twice the number of pure sales in the last three years.[11]

Data shows that the change towards electric mobility is powered by the myriad of push and pull policies that exist across the state. These include the state's Zero Emission Vehicle regulation, consumer rebates, access to carpool lanes on congested highways, electric vehicle charging infrastructure, progressive electric utility policies, greater model availability and marketing, and continued growth of local electric vehicle promotions. Perhaps the highlight of the Californian EV industry is the success of Tesla Motors, founded in 2003 and based in Fremont, California.

In **summary**, the government and various institutions see electric mobility as a solution for a cleaner environment and are promoting and targeting that industry accordingly. Measures and subsidies to achieve these goals are currently being implemented or accompanied at every level.

In this Market Study, we focus on the state of California and several selected cities. Some core figures on these cities are provided in Table 2.

Table 2 Facts and figures for the selected cities[12]

	California	Los Angeles	San Francisco	Sacramento	Portland (Oregon)
Population	39.51 Mio	3.98 Mio	881,549	513,624	654,741
Area in km2	432,970	1,302	121	258	376
Public charging stations[13]	27,678	6,607	6,736	950	432[14]
Shared private charging points[15]	39,665	11,902	14,652	815	797[16]
Area's median household income[17]	$ 80,440	$ 77,774	$ 114,696	$ 72, 017	$ 76,231
Total housing units	14,084,824	1,474,043	393,975	195,749	282,139

[11] https://evadoption.com/ev-market-share/ev-market-share-state/ ; veloz.org ; CEC (2020) via www.energy.ca.gov/zevstats

[12] United States Census Bureau 2020 (www.census.gov) ; afdc.energy.gov: 20 miles radius; www.veloz.org; www.business.ca.gov;

[13] https://www.energy.ca.gov/data-reports/energy-insights/zero-emission-vehicle-and-charger-statistics

[14] https://chargehub.com/en/countries/united-states/oregon/portland.html

[15] https://www.energy.ca.gov/data-reports/energy-insights/zero-emission-vehicle-and-charger-statistics

[16] https://www.plugshare.com/directory/us/oregon/portland-vancouver-hillsboro

[17] https://censusreporter.org/profiles/16000US4159000-portland-or/

2.2 San Francisco

General information

San Francisco is the fourth largest city in California, with 881,549 inhabitants and an area of 121 km.[2] It is also one of the most prosperous and dynamic cities in the country. The city is considered the financial center of California and one of the most important financial centers in the world. By American standards, San Francisco has a well-developed public transportation network. At the end of the 20th century, companies of the New Economy settled south of the city in Silicon Valley, the most important location of the IT and high-tech industry worldwide. More than 7,000 companies, 500,000 employees and $180 Bn revenue are located in the surrounding area.[2] San Francisco is one of the fastest growing cities in America. The extreme increase in jobs and population has led to an enormous increase in traffic, resulting in new levels of traffic jams and air pollution issues. Therefore, the city has been trying to turn the traffic around for several years.

EV policies

In the year 2018, departments from across the City of San Francisco and companies of the private sector developed the **EV Roadmap**. This Roadmap should help to reduce the greenhouse gases in San Francisco. The effort, led by San Francisco Environment, San Francisco Municipal Transportation Agency (SFMTA), and the San Francisco Public Utilities Commission (SFPUC), has resulted in six program areas which are meant to help advance strategic electrification efforts across the transportation sector.[18] They are:

- **Public Awareness:** Achieve broad public awareness, understanding and consideration of the options and benefits of electric mobility.
- **Incentives:** Create a preference for electric mobility over gasoline and diesel vehicles.
- **Charging Infrastructure:** Ensure that charging infrastructure for EVs is available and convenient for all residents, businesses, and visitors.
- **Grid:** Integrate EV charging with the electrical grid to maximize the benefits of charging infrastructure and support the transition to a renewable energy future.
- **Medium- and Heavy-Duty:** Lead the way in medium- and heavy-duty vehicle electrification.
- **Emerging Mobility:** Advocate for and encourage emerging mobility options to be emission-free.

In addition, the stakeholders in San Francisco built the so-called **Electric Vehicle Ready Community Blueprint**, which is a development of the roadmap. The different goals for the city of San Francisco include:

- Reaching net-zero emissions by 2050
- 100% of all private transportation GHG-free by 2040
- 100% renewable electricity by 2030
- 80% sustainable trips by 2030
- Electrify the SFMTA diesel-fueled transit buses by 2035
- 50% of new passenger vehicle registrations being EVs by 2025, 100% by 2030

By setting clear goals and preparing reports to promote electromobility, the city has laid a good foundation for the expansion of electromobility. This can be a promising ecosystem for Dutch companies. However, the city itself also has significant barriers to achieving these goals. For one thing, salary levels in San Francisco are widely disparate, which means that not all people, institutions or companies can afford to electrify. Another challenge is the city's urban design. San Francisco consists of many apartment buildings in a very small area, which makes it difficult to provide charging infrastructure.[19] Such multi-unit dwellings (MUD) pose one of the major challenges to the expansion of EVs, and such housing- and building differences demonstrate the importance of the

[18] https://sfenvironment.org/electricmobilitysf ; Download the Roadmap here: https://sfenvironment.org/sites/default/files/fliers/files/sfe_tr_ev-roadmap.pdf

[19] www.cleancitiessf.com/bevs

government's equity concerns: how to make the energy transition accessible and affordable for all.

Status of the EV market

San Francisco and the Bay Area is home to many famous companies, such as Facebook, Twitter, Airbnb, and Fitbit. These companies also actively support the expansion of charging stations in the region. These EV charging stations are offered by various charging networks such as ChargePoint, Blink, EVgo, Volta and Tesla. There are currently almost 7,000 public charging points in San Francisco. It is assumed that about twice as many charging points can be found on private, semi-public and company properties. California's government does not provide a validated number of registered electric vehicles in the city or region, but the ICCT estimated in 2019 that more than 100,000 e-vehicles were in use in the region.[20]

2.3 Los Angeles

General information

Los Angeles (LA) is the largest city in California, with an area of 1302 km². Approximately 3.98 million inhabitants live in the city. It is a national center for business, culture, education, research, and innovation. In addition to its aerospace clusters, LA is particularly well known for the Hollywood film and television industry based here. A high level of urban sprawl and high building pressure characterizes the city, and the city is broken up like a mosaic into a multitude of individual city districts. The districts have different functions, like business districts or residential areas, and are clearly differentiated from each other. But regardless of where you are, the car is the number one mode of transportation. The entire city area is developed along the major connecting highway axes. As a result, LA has some of the worst smog problems in the US.

The city, like many American cities, is now dealing with high real estate prices and rents, even in formerly undeveloped areas. Now, LA is said to be a city of high gradients: here you can find very poor and very rich inhabitants.

EV policies

Due to the high volume of traffic and poor air quality, the City of Los Angeles has created **the Zero Emission 2028 Roadmap 2.0** for the Los Angeles region; the plan targets the year the Olympic Games will take place in LA. The city founded the Transport Electrification Partnership to build a force behind this roadmap, partnering with the state and CARB, private partners like BMW, Tesla, Audi, BYD, and some energy companies. The roadmap focuses on the reduction of CO2 through electric cars, buses and trucks. Goals (all to be achieved by 2028) have been defined as:[21] [22]

- Reduce GHG emissions and air pollution by an additional 25%
- 80% of all new vehicles sold in LA should be electric
- 60,000 to 130,000 public chargers installed
- 20-45% of all light-duty private vehicles on the road are electric
- 50-100% of shared cars (e.g., taxis) are electric
- 80-100% of Metro and LADOT buses on the road, and 100% of new buses being introduced are electric
- Begin planning for electrification of one or more commuter rail lines with key partners
- All disadvantaged communities with a walk score of less than 65 have Light Electric Vehicle hubs to reduce single-occupancy vehicle trips (shared mobility hubs)
- Ensure short-haul and Vertical Take-Off and Landing transit is electric
- 10,000-100,000 zero emission chargers installed for goods movement
- 10-40% of drayage trucks on the road are zero emissions

[20] https://theicct.org/publications/ev-capitals-of-the-world-2019

[21] The Roadmap 2.0 can be found here: https://roadmap.laci.org/wp-content/uploads/2019/02/LACI-ROADMAP-V7-FINAL-HI-FI-1-020819.T6J-2.pdf ; https://laincubator.org/roadmap/

[22] www.electrive.com/2019/11/29/los-angeles-takes-aim-at-80-electric-sales-by-2028/

- 5-25% of trucks on the road are zero emission vehicles
- 25-50% of medium-duty delivery trucks are electric

Roadmap 2.0 has ambitious goals, however less attention was paid to the steps required to reach these targets. Several questions have been raised that should be answered in the next years:

1. What level of EV charging infrastructure would be sufficient to address range anxiety?
2. How do we streamline and standardize the permitting process for charging infrastructure across the Greater LA region?
3. How do we accelerate the installation of charging infrastructure into existing and new multi-family-housing?
4. How do we harmonize education and incentives for EV purchasing across utility service territories?

These questions show several of the core challenges that cities in California face, including low EV-awareness, equity challenges (especially deployment of charging infrastructure in high density areas) and the quest how to upscale the charging network to the necessary levels to take away charging infrastructure as a barrier to EV-adoption. Roadmap 2.0 also set targets and raised future questions for the topics of good transportation and the energy grid (see chapter 4).

Current status of the EV market

Los Angeles is likely the second most developed EV market in California and America after the Bay Area. The city currently has around 6,000 public charging points. While this is large in absolute terms, it is still insufficient to cover the city's massive and still growing population. A major challenge in building out that infrastructure is simply LA's size: the metropolitan area is massive and falls under several jurisdictions, which means that a concerted charging effort (and the local laws that regulate charging stations) are inconsistent and patchwork.

Although a validated number of registered electronic vehicles is not available for the city, sales data suggests that approximately half of the state's total EV sales are in the LA metro area.

The city is trying to actively change its car centric lifestyle and reputation. Originating from the Roadmap 2.0, participating partners have launched several mobility pilot projects representing investments of $500,000 to bring EV car-sharing and micro mobility to four disadvantaged communities in the LA region that lack adequate mobility options. These are Pacoima, San Pedro, Long Beach and Huntington Park. The city has also bolstered its public transportation by purchasing 130 new electric buses from BYD.

2.4 Sacramento

General information

Sacramento is the capital of the state of California, with 513,624 inhabitants and a size of 258 km^2. It is also one of the most rapidly growing cities in California, powered by people leaving Los Angeles and the Bay Area seeking cheaper costs-of-living. Due to the flat topographical conditions in the city area and the climatic situation, cycling is very popular in Sacramento.

EV policies

In 2017 Sacramento published its first Electric Vehicle Strategy.[23] The actions included in the Strategy will be initiated by 2020 with full implementation by 2025. They outline the city's intended trajectory for zero-emission mobility. This strategy was updated most recently in 2020[24]. The plan established goals of:

- 75,000 ZEVs in Sacramento
- 35% of households with ZEVs
- 40% of annual sales to be ZEVs

[23] www.cityofsacramento.org/-/media/Corporate/Files/Public-Works/Electric-Vehicles/EVStrategy_171212_FINAL_CityOfSacramento.pdf?la=en

[24] www.cityofsacramento.org/-/media/Corporate/Files/Public-Works/Electric-Vehicles/EV-Strategy_Progress-Report_Final_July-2020.pdf?la=en

In the city's first evaluation of what has happened since 2017, two accomplishments stand out:

- 1,600+ new ZEV registrations and 52% increase in ownership
- Gap of over 70,000 ZEVs to attain 2025 goal

The city also mentioned other goals in the field of mobility:[25]

- Reduce communitywide vehicle miles traveled (VMT) per capita 7% by 2020 and 16% by 2035.
- Reduce GHG emissions from the city's municipal vehicle fleet fuel by an average of 3% per year between 2005 and 2020.

Current status of the EV market

Electric mobility in Sacramento is expected to develop strongly by 2025. A total of nearly 4,900 electric vehicles are registered, and the city itself has over 900 public charging points in the city area.[26]

Within its Electric Vehicle Strategy, the city is trying to set up a platform that makes it easier for private and public partners to develop and invest in the field of electric mobility.[27]

For the downtown area in Sacramento, 12 new charging stations are planned and partly implemented already. EVgo acts as a major partner here. Highly visible curbside chargers can provide charging in dense areas of downtown where charging options are limited, and for residents without a garage or dedicated off-street parking.[28] For these dense areas another electric vehicle parking program was initiated, but it is currently on hold due the COVID19 pandemic.[29]

2.5 Portland (Oregon)

General information

Portland is the largest city and the economic center of the state of Oregon with 654,741 inhabitants and a size of 376 km.^{2} Portland is considered to be a very liberal city, which attracts artists, creative people, and start-up companies. As a result, the city is considered as the "European" city in America. Portland has a high influx of young academics.[30]

EV policies

Like California, **Oregon** has set ambitious targets when it comes to EVs. Oregon has the goal of having a total of 50,000 electric vehicles registered by the end of 2020. To encourage people to buy an EV, the state has introduced the Oregon Clean Vehicle Rebate Program. The program has options for both new and used electric vehicles, including extra support for low- or moderate-income households. Concerning fast chargers on busy corridors, Oregon has leveraged federal funds and Volkswagen settlement funds through Electrify America, which will help shape investments in charging infrastructure.[31]

The state of **Oregon** establishes partnerships with its large, investor-owned utilities as well as its smaller consumer-owned utilities to develop future plans that encourage EV adoption, improve charging infrastructure and help achieve a transition to an increased number of EVs charging on the grid. In addition, state

[25] www.cityofsacramento.org/Public-Works/Facilities/Sustainability/Resources/Mobility

[26] www.cityofsacramento.org/Public-Works/Electric-Vehicle-Initiatives/EV-Charging-Locations

[27] www.cityofsacramento.org/Public-Works/Electric-Vehicle-Initiatives/EV-Strategy

[28] www.cityofsacramento.org/Public-Works/Electric-Vehicle-Initiatives/Curbside-Charging

[29] www.cityofsacramento.org/Public-Works/Electric-Vehicle-Initiatives/EV-Charging-at-City-Facilities

30 www.roadsnacks.net/most-liberal-cities-in-oregon/ ; http://greatdestinationsradioshow.com/2017/07/27/visit-portland-the-most-european-city-in-america/

[31] www.oregon.gov/deq/aq/programs/pages/zev-rebate.aspx

agencies are working on building codes that require new building parking structures to be ready to support EV charging by October 2022.[32]

The city of **Portland** is considered a pioneering city for electromobility in the US, having developed its first (electro)mobility strategy in 2010. Portland itself has updated this first mobility strategy 2010 (Portland Strategy) to the first special electronic strategy in 2017. Goals include:[33]

- Reduce carbon emissions by 40% by 2030
- Reduce carbon emissions by 80% by 2050
- Reduce the number of people commuting in single occupancy vehicles from 59 percent to 20 percent by 2030.
- 50,000 electric vehicles in the metro area by 2030
- Replace at least 10,000 gas- or diesel-powered vehicles with electric vehicles in Multnomah County by 2020
- Increase access to electric vehicle charging infrastructure by doubling the number of level 2 and DC fast chargers available to the public by 2020
- Add 60 electric vehicles to the city's sedan fleet to increase the percentage of electric vehicles from 20 to 30 percent. Seek options to electrify other classes of vehicles in the city's fleet by 2020
- Prioritize the electrification of shared use vehicles, bikes and buses to reduce the need for personal vehicle ownership till 2020.

The city made a priority list of where to deploy charging infrastructure. These areas are identified as those with:

- Fewer existing public charging stations.
- Limited access to frequent transit and bike routes.
- Higher proportions of multifamily housing and garage-free homes.
- Large businesses with employees commuting long distances.
- Residents with higher average vehicle miles traveled.
- Destinations (recreation sites, event venues, etc.) people tend to travel longer distances to access.[33]

Current status of the EV market

As of August 1, 2020, **Oregon** had 32,389 registered electric vehicles and 1,673 public chargers in 639 locations.[34]

Portland tries to reach its EV goals by starting action plans in the field of charging infrastructure next to buildings and in public areas, the electrification of fleets, supporting mobility as a service, making campaigns and providing information, and, to support the economic development in these fields, to support Portland's leadership in clean technologies.[35] The number of registered electric cars in Portland is unknown. There are now about 430 public charging stations in the city.[14]

[32] https://goelectric.oregon.gov/2020-goal

[33] www.portland.gov/sites/default/files/2019-07/final_electric-vehicle_report2016_web.pdf

[34] www.oregon.gov/energy/Data-and-Reports/Pages/Oregon-Electric-Vehicle-Dashboard.aspx

[35] www.portland.gov/sites/default/files/2019-07/final_electric-vehicle_report2016_web.pdf p.11.

3. Challenges in upscaling charging infrastructure

As the number of electric cars increases, so must the number of charging stations. As described in the previous chapter, Californian policies have ambitious targets when it comes to zero emission vehicles and charging. The expansion of the charging infrastructure in California and the West Coast is focused on three components:

- **Providing access to charging in multi-unit dwellings**
- **Building out destination charging (including workplaces and points of interest, such as shopping centers, hotels, parks)**
- **DC fast chargers for high volume and high intensity use [36]**

This chapter describes what is happening in charging infrastructure in California and the challenges the state faces in its aim to upscale the charging infrastructure network and making "electric for all" a reality.

3.1 A swift start in California

Electric vehicles play an important role in California's efforts to reach its ambitious air quality and climate goals. The state is working hard to reach its goal of 5 million ZEVs on the roads by 2030 and 250,000 charging stations (including 10,000 fast chargers) by 2025. The state of California is closing in on these goals, with the number of chargers expanding each week. Despite these efforts, however, a recent CEC report on funding electrified transportation published in October 2020 warns that "charging infrastructure investments are growing at a slower pace compared to trajectories of electric vehicle adoption"[37].

[36] https://businessportal.ca.gov/zero-emission-vehicle-program/path-to-2030/

[37] https://www.greentechmedia.com/articles/read/california-targets-384m-to-fill-gaps-in-electric-vehicle-charging-infrastructure

It is also important to note that Californian policies and funding initiatives pay attention to driving economic development and reducing pollution in low-income and disadvantaged communities. Roughly half of the state's funds are designated for projects in those areas.

Nonetheless, there is still work to do before EV driving and charging becomes the regular option. Research initiated by the Bay Area Air Quality Management District (BAAQMD) that was presented in May 2020 found that major concerns for EV driving among Bay Area residents include EV battery range, home and public EV charging, and EV repair costs[38]. Technical battery range and EV repair costs are the domain of OEMs and manufacturers, but increased EV awareness may take away some of these concerns. Helping the charging infrastructure network to grow and to be more visible will also contribute to encouraging EV-adoption.

3.2 Paving the way for upscaling charging infrastructure

Electromobility must play a crucial role in California's efforts to reach its climate and air quality goals. But for that to happen, people must drive EVs. A visible, stable, and accessible charging infrastructure is integral to increasing EV adoption. The following sections detail the challenges to be tackled along the way.

Alternative charging solutions in dense areas and MUD neighborhoods

California and its cities deal with unequal charging infrastructure distribution. EV-adopters have been, to date, wealthier and more likely to live in single-family

[38] https://www.baaqmd.gov/~/media/files/board-of-directors/2020/tio_presentations_05152020-pdf.pdf?la=en

homes than the average US resident. Neighborhoods with many multi-unit dwellings (apartment buildings) are a huge challenge for both EV-adoption and finding suitable and affordable locations for charging infrastructure. Zooming in on the latter, there are physical limitations in high density areas, exacerbated by strict building codes and permit requirements (California is working on streamlining its permitting process – the current process is known for slowing down deployment and increasing charging infrastructure costs).

To help increase public charging infrastructure deployment in dense areas, one of the solutions is to find alternative solutions to the classic charging station (EVSE). For example, in LA they have found that integrating charging with street lights works very well. This will not be the sole solution, however, since the (street light) grid is not suitable to connect as many EV chargers. Another pilot project in Portland, to test whether EV charging on utility poles can help provide more charging options, confirms this need for alternatives. This helps reduce the amount of infrastructure required and creates an opportunity for people who do not have a private driveway or garage.[39] Dutch experience in alternative charging solutions (Lightwell, Streetplug, and others) and on how to squeeze charging infrastructure into urban environments could be especially useful here.

As EV-adoption is yet in its early phase, commercial investments are less likely since utilization is not high enough to ensure a valid business model. In addition, state grants often have utilization requirements, which do not encourage deploying charging infrastructure in neighborhoods with currently low EV adoption rates.

Partnering and combining services to ensure a valid business model

The state of California and the private sector, including companies such as EVgo, VW, Tesla, Nissan, and BMW, are cooperating in the expansion of charging infrastructure. The West Coast Electric Highway is a good example of a private-public electric mobility project in the US, installing charging stations every 40 to 80 kilometers.[40] Electrify America (the VW settlement fund) is one of the largest private investors in the Californian charging infrastructure, with investments reaching up to 800 million dollars. Tesla is another large investor with its unique strategy of building its own charging network (at a loss) as part of their competitive strategy to increase vehicle sales. Note that almost half of all EV sales in the US are Tesla's. Other car manufacturers are partnering with charging service providers to install charging infrastructure. Most of the public infrastructure outside of Tesla chargers has been funded through site-hosts, OEMs, venture capital and government programs. [41]

Due to low utilization rates and high capital costs, both public charging site hosts and charging service providers face a difficult business case when installing infrastructure. Opportunities can be found in combining charging infrastructure with other products and services. EV stakeholders should invest in partnerships to expand the variety of (smarter and more complex) products and services to offer. For (Dutch) companies that sell charging infrastructure, partnering with utilities could ensure making their offerings more competitive and reliable. The city of LA indicated they are planning to issue a "sort of procurement" in which they work with five or six charger manufacturers that can submit a bid each time LA wants to deploy charging infrastructure (framework contract). Such contracts also offer opportunities for establishing longer term partnerships and (name) recognition for companies.

Lack of EV awareness and knowledge

In all interviews it was mentioned that a general lack of EV awareness and knowledge among potential users is one of the main challenges slowing down growth. Overall, there is a low demand and willingness to pay for EV charging. Consumer experience challenges are prominent, such as lack of standardization, interoperability issues, and equipment failures. Prices of public charging are set

[39] https://www.portlandgeneral.com/residential/electric-vehicles-charging-stations/basics-of-charging

[40] http://www.westcoastgreenhighway.com/electrichighway.htm

[41] https://www.nrdc.org/sites/default/files/charging-infrastructure-best-parctices-202007.pdf

by networks or property owners and charging can be free, pay-as-you-go or subscription-based.

Programs that let potential users experience what it is like to drive electric work well for both light duty as well as medium and heavy duty vehicles. Investing in such programs may encourage EV adoption and sales of both vehicles and charging infrastructure in the long term. Also, simplicity is key. When charging is simple, roaming works well, the payment system works well, and the user can influence the charging session, charging becomes much more attractive and accessible. Dutch experience and knowhow in these fields could assist Californian public bodies and utilities.

3.3 Longer term developments

Technological developments

California's policy leaders have tried to be hands off and let the market declare victors; competing charging technologies, standards, and plug in type are still open to competition. These shifting sands in the realm of technological innovation and preferences pose business risk but also allow newcomers to change the status quo. Whether they be payment systems, platform providers, or simply manufacturers with a different standard, companies who can find a market (or build one) are welcome. This of course, means any innovations could lead to even more deviating technologies going forward.

Heavy duty charging infrastructure

California's unique geography lends itself to soaring mountains and valleys, but also promotes smog and particulate matter buildup. The heavy duty sector disproportionately contributes to these phenomena, and the State has targeted it for dramatic electrification. The accompanying infrastructure will be a huge lift, and many are already thingking about expensive charging depots, charge in line technologies, and chargers pumping through thousands of kilowatts of energy. Businesses with talent in this space would do well to work with logistics, delivery, and other partners to build these depots in the medium and long term.

Other developments on smart and green mobility in California

Electric mobility is not the only show in town for California. Beyond electrification, California policy makers and business are exploring and developing technologies in the fields of autonomous driving, Mobility as a Service, and green hydrogen as ways to reduce congestion and improve air quality.

California's business community has raced to see who will develop a fully autonomous driving module first. The state is the largest and most important testing ground for **autonomous driving** in the US. In the corporate fleets of GM Cruise, Uber, Apple, Waymo Auto and Tesla operate fleets of test vehicles. The California Department of Motor Vehicles announced approximately 50 companies have submitted applications to test autonomously controlled vehicles on California roads.

Other alternative fuels also attract attention and investment. A total of 42 **hydrogen** fueling stations are located in California, with state goals of 200 hydrogen filling stations by 2030. The technology is seen as particularly promising in the heavy duty space, though major companies like Toyota and Hyundai are also producing passenger vehicles.

Lastly, many established companies such as Sway Mobility, SHARE, and Oracle offer **Mobility as a Service**. These business models appear as an excellent way for consumers to be exposed to EVs, as well as reduce congestion, parking issues, and greenhouse gases. Some cities, like Sacramento and San Francisco, offer EV car-sharing services through partners like AAA and Electrify America.

4. The road to Vehicle Grid Integration

Vehicle Grid Integration (VGI) is the term used to describe the broader suite of EV charging services that help manage grids. From simple time-of-use rates designed specifically for EVs to vehicle-to-grid (V2G) technologies that utilize bidirectional charging, the potential for VGI is vast. Studies have suggested it could offer a promising solution to California's reliance on renewables like solar and wind energy, balancing hour loads and shaving peak loads by as much as 10%.[42] The future of VGI is still an open conversation across California, where the impetus for action is large but so are the hurdles. Grid resilience, capacity, and communication stand out as challenges facing utilities and generators alike, while only small and experimental pilots have been executed to prove VGIs viabilities. Companies that can make their mark publicly will be able to shape the future of VGI statewide.

Examples of pilots and projects on VGI in California

- The California PUC adapted the 'electric rule 21' in September 2020 so that it is easier to feed energy into the grid
- Nuvve Corporation project with San Diego Gas & Electric
- Nissan Leaf and Wallbox working on bidirectional charging
- Nissan LEAF-to-Home system
- Honda, BMW, and Mitsubishi run demonstration projects
- Proterra has released a V2G-enabled transit bus
- Enel X (formerly MotorWerks) built hardware
- Study of BMW and Partners about V2G (2017)
- the Bus-Company Blue Bird started several pilots with their buses

[42] https://rmi.org/wp-content/uploads/2017/04/RMI_Electric_Vehicles_as_DERs_Final_V2.pdf

4.1 VGI in California preparing for the early commercial phase

In the US, smart charging is often referred to as Vehicle Grid Integration (VGI). Within it, the Vehicle to Grid (V2G) and Vehicle to Building (V2B) are the technologies that enable energy to be pushed back into the grid from the battery of an electric car. This can contribute to load management and lead to a more stable grid and energy distribution.

The California Public Utilities Commission (PUC) has begun convening the DRIVE OIR Vehicle-Grid Integration Working Group. This group will answer three questions:

- What VGI use cases can provide value now, and how can that value be captured?
- What policies need to be changed or adopted to allow additional use cases to be deployed in the future?
- How does the value of VGI use cases compare to other storage or Distributed Energy Resource (DER)?[43]

The final report of this working group was published in June 2020. The report concludes that most VGI use cases are considered as able to provide value by 2022 or longer term. Policy recommendations include reforming retail rates, and funding and launching market education and coordination methods.[44]

[43] One can find results, events, and more information on the following websites: www. gridworks.org / https://www.cpuc.ca.gov/vgi/

[44] https://gridworks.org/wp-content/uploads/2020/07/VGI-Working-Group-Final-Report-6.30.20.pdf

Single cities are pushing pilots and research in this field as well. The city of Los Angeles posed questions in its Roadmap 2.0 in the field of V2G which should be answered by 2028:

- How can we ensure that long-term energy resource planning considers the local transmission and distribution infrastructure capacity needed to meet the demands of transportation electrification?
- How do we integrate more renewables and batteries to support electrification of transportation and grid resilience?
- How do we prepare for an electrified vehicle future where the grid communicates its requirements to connected vehicles in real time?
- How does the electricity grid both prepare for and enable autonomous vehicles and new operating models, such as Mobility as a Service (MaaS), and utilize technologies like blockchain-based encrypted payments, induction charging, IoT devices, and others?

Also, the city of Portland (Oregon) is looking for pilot projects in this field.[45]

Currently, it can be said that there are mainly pilot projects in this area, but all major cities in California are interested in a solution and have spent some funding on it. However, a single system governing VGI has not yet become generally accepted. California has given real impulses in the right direction through research and new policies and regulations.

4.2 Methods to improve VGI implementation and effectiveness

The entire suite of VGI products and services face sincere challenges to reaching their potential for managing California's grid capacity and handle the "duck curve" caused by excessive renewable power during some hours. Fixing this begins with altering behavior. Thus far, utilities have installed time-of-day rates to incentivize charging during "off-peak" hours, which can range from the early afternoon when solar energy is in abundance or late at night when overall demands on the grid are low. But many Californians continue to charge as soon as they get home from work (5-8pm), resulting in inefficient use of resources. Utilities spoke of frustration in managing peak loads and concern for the future of home charging as batteries get larger and chargers more powerful.

It is also true that that new methods of "nudging" consumers are needed to manage grids in these early days of electrification. Such nudges must not only push consumers in the direction of charging in off-peak hours, but also to continuously charge at low levels. There is value to be created by shifting consumers away from overreliance on expensive DC fast charging which, while potentially convenient, strains grid infrastructure even more. These grids will face even more demand in the future as commercial vehicles, from delivery vans to heavy duty trucks to rideshares, face pressure to electrify. Shifting also saves drivers money, a potential pricing feedback that many of them may be insufficiently aware of. The idea of real-time energy pricing for charging, while potentially incredible for utilities and drivers alike, faces multiple technological and organizational hurdles; some utilities do not want to build such a system themselves.

Thus far, focusing on pricing signals for most utilities has been in the space of vehicle telematics, where vehicles are programmed to stop or start charging depending on the time (and thus the corresponding price), or programmable chargers. The fiscal costs of networked smart chargers are difficult for many people to justify since they often cost hundreds of dollars more than their non-networked alternatives. Further, 31% of Californians are under connected to broadband, posing difficulties to mass adoption of networked chargers.[46] The long-term benefits of such smart chargers only manifest if a critical mass of people is connected. Managing the costs and back end of such a system is beyond the scope of some consumers and utilities, respectively.

[45] www.portlandoregon.gov%2Fshared%2Fcfm%2Fimage.cfm%3Fid%3D309915&usg=AOvVaw1LjeHL7RtTR3zD3HRL7no9

[46] https://www.unitedwaysca.org/opinion/448-closing-the-last-miles-of-california-s-digital-divide#:~:text=According%20to%20a%20just%20published,and%20from%20the%20digital%20economy

Overall, the market for VGI services is just beginning to develop and the most exciting technologies, such as bidirectional charging and V2G (discussed below), have yet to see practical commercial applications. There is much to be decided, and many opportunities in the process.

4.3 Longer term developments

The most exciting technology, and likely the one with the most challenges in the VGI suite, is the V2G space mentioned above. The long-term vision is clear: thousands of EVs acting as a massive and distributed battery network for an intelligent grid, working to build a better, lower cost, and carbon free energy system.

In the medium term, the V2G space faces serious difficulties getting off the ground. Consumers will not adopt VGI technologies until they realize its value in the form of savings (or even revenue); this parallels the need for "nudges" mentioned in the prior section.

Further physical barriers prevent some of the easiest types of adoption; a solar and EV homeowner seems a likely and perfect fit for a small scale V2G system; its self-fueling nature would ensure that thousands of Californians could live off the grid for days, even if the grid goes down. But many Californians do not live on "islanded" homes which can isolate from the grid. The result: when power goes out, so does the solar and battery backup. Islanding requires expensive hardware and EVs require inverters for such resiliency plans to work. Better business cases and novel technologies could accelerate adoption in this space.

V2G and V2B technology is far more likely to be adopted by commercial and government customers, who have a much larger economic imperative to build electric resiliency and shave energy consumption during peak hours. Commercial areas, such as stores and warehouses, could lose thousands if refrigeration goes out for more than a few hours; the potential here for delivery vans or heavy-duty truck backup is immense. Governments have keyed in on the potential for fleets of electric school buses, out of use much of the day, to feed energy back into the grid when they are out of use. With buses aiming for total electrification by 2040, it would not be surprising for most early pilots to focus on these vehicle types.

Altogether, the future of VGI is far from set, and no technology is preordained. Companies who can prove their technology works to stakeholders will be able to help dictate the future in this space. Further, public opinion has not fully captured the potential for VGI. High profile demonstrations with high profile customers, such as sports teams or museums or large businesses, will allow businesses to build a reputation across the state.

5. Electrifying fleets in California

In like-for-like vehicle replacements, ICE vehicles rarely make financial sense when compared to their electric counterparts. Electrified transportation's lower maintenance and operating costs simply offer economic advantages that traditional vehicles cannot. Such cost savings make even more sense at scale, when returns on gas and repair savings quickly equal the value of entire vehicles. This chapter details the efforts of public and private sectors alike to electrify their fleets, the regulatory and self-imposed goals they aim to achieve, and the challenges (and opportunities) lying in their way.

5.1 California has aims for total fleet electrification

It is no wonder that savvy fleet operators have shown a willingness to turn convert to EVs. From governments to private delivery services to the logistics sector, the savings are beginning to make more sense as the offerings from EV manufacturers expand. Altogether 66 different EV car models drive the roads of California, which helps to explain the steady progress towards electrification government fleets have made. Many cities, including Portland, have begun to adopt "zero emissions first" purchasing protocols when acquiring new vehicles. Others spend considerable resources on shared building charging infrastructure.

There is substantial support for governments (and individuals) seeking to convert to EVs. In the light duty passenger vehicles sphere, several tax credits, incentives, and rebates exist at every level of government to support the EV market. Federally, electric vehicle purchases receive a $7,500 tax credit, scaling down depending on the size of the battery. This credit is phased out gradually, however, when a manufacturer's sales of electric cars surpass 200,000 units. So far only General Motors and Tesla have reached this limit. State wide, the California Clean Vehicle Rebate Project (CVRP) offers up to $2,000 for buyers below certain income thresholds on new vehicles. California also offers low- and moderate-income subsidies through the Clean Vehicle Assistance Program. And finally, local utilities and other stakeholders offer incentives of varying size and scope depending on location and income.

The logistics sector is also a target of California's regulators seeking to electrify fleet vehicles. The Advanced Clean Trucks Rule (2020) will compel heavy duty electrification to begin as soon as 2024, while buses aim for complete electrification by 2040. The challenges are significant; there is not yet a commercially available Class 8 electric truck, and building enough high voltage charging stations to fuel fleet after fleet poses enormous technical and financial challenges.

Nonetheless the market has responded. Tesla announced new long-distance and urban freight transport e-vehicles for customers such as UPS, PepsiCo, Walmart, and Meijer. Other OEM's and startups, such as Rivian and Ford, are targeting the last mile delivery sector through existing partnerships with Amazon and local businesses. The e-logistics industry is likely to be crowded, as offerings are also coming forth from Proterra, PACCAR, Capacity trucks, Cummins Inc, Unique Electric Solutions LLC, and Nikola Motor.

5.2 Analysis per fleet type

The different fleet types have been analyzed separately on the following table. Per fleet type, we name the goals and context, a short market analysis and challenges and opportunities.

Fleet Type	Stakeholder	Goals and Context	Market Analysis	Challenges and Opportunities
Government Fleets	Los Angeles	Los Angeles was an early pioneer in zero emission procurement, but a series of setbacks have slowed the city's progress (e.g. electric police cars were returned underused). Under the Los Angeles Green New Deal, released in 2019, Mayor Eric Garcetti has set a "zero emission first" policy and aims to **convert all the city vehicles by 2028**.	Government fleet electrification can truthfully only go as far as light duty passenger vehicles are accepted. Now that long range battery powered vehicles are on the market and beginning to achieve widespread acceptance, EVs may finally be preferable to the ICE alternatives. But **lack of knowledge and familiarity** amongst employees will also hinder their use and result in underutilization. Parts of some fleets will simply take longer to electrify. Work trucks and parks departments, which rely on **heavy payloads or off-road capability**, are simply incapable of being widely electrified at this moment in time. Other departments, especially those in the public safety sphere, are wary of being caught without range in an emergency.	Cash strapped cities are always looking for new ways to cut costs. EVs support such efforts by the immediate effects, such as lower fuel and maintenance costs, as well as secondary effects around lower air pollution. Accessing such benefits is difficult, however, because of the higher upfront costs and limited (but rapidly expanding) EV options. **Behavioral training for employees**, such as teaching them to think in terms of range or to favor level 1 and 2 charging.
	San Francisco	San Francisco's goals are the most aggressive in the nation, mandating **electrification by 2022** and requiring that 100% of all future off-street parking spaces be made ready for charging installation. Geographical limits make EVs an easier choice than less dense cities.		
	Sacramento	Consistently one of the greenest fleets in America, Sacramento's municipal fleet is **over 50% EV**. The City was an early leader in green charging as well, launching solar powered charging stations for municipal vehicles as early as 2011.		
	Portland	Portland plans to institute a similar "zero emission first" policy for its fleet vehicles, aiming to increase the EV share of its fleet to **30% in 2020**. Portland also aims to expand its 50 fleet charging stations, as well as moving to expand public/private/shared chargers throughout the city and underserved areas.[47]		

[47] https://www.portland.gov/bps/scg/fleet-emissions

Fleet Type	Stakeholder	Goals and Context	Market Analysis	Challenges and Opportunities
Ride Hailing Services and Cabs	Ride Hailing Services & Traffic Network Companies (TNCs)	California is the birth place of the world's foremost ridesharing apps: **Lyft and Uber**. The services' growth has been a boon for productivity and families who do not own cars, but unwelcome news for the environment. CARB estimates that each trip via ride-hail produces 1.5x the emissions of the average car trip.[48] So electrifying ride-hailing vehicles could save three times the emissions than other cars. As such, it is no wonder that CARB began moving towards regulating the Silicon Valley giants and mandating electrification. In 2020 the regulator proposed the "Clean Miles Standard," a target of 60% of the total vehicle miles traveled as electric. Lyft and Uber have been receptive publicly, and Lyft pledged to **electrify fully by 2030**.[49] CARB's regulations are the first of their kind in the US and will likely set an example for other like-minded states, such as Oregon and Washington.	Ride hailing electrification of ride hailing services falls behind that of personally owned vehicles, and of the 2-3 million drivers in the US, only 0.5% drive an EV. Beyond purchase prices, which pose immediate difficulties for driver access, the biggest **roadblock is public charging**. An estimated 40% of non-Tesla fast charging is done by TNC-EV drivers, many of whom who rarely charge at home. This builds high demand during certain peak TNC times, leading to waiting times at public charging stations.[50] Data also shows that drivers tend to charge in the midday hours, when solar and other renewable energy is plentiful. Keeping this behavior unchanged will be crucial to keeping costs low and emissions down. Overall, TNC electrification is in the earliest stages of development, and will likely be more resistant to electrification based solely on **the time it takes to charge**.	Research and interviews both point to **developing fast charging hubs** for ride sharing vehicles as a major goal; electrification simply cannot happen without it. Creating a hub where 20+ vehicles can DC fast charge, however, is not easy. Getting all the stakeholders, such as the app providers, utilities, cities, and others, is another challenge. Data also suggests that access to charging allows ride-share drivers to better plan their workday.
	Taxis	Taxi regulation typically falls to local governments and cities, and attempts to electrify have met **limited results**. San Francisco prepared an electric taxi pilot in 2010, but it never launched. Meanwhile, in places like LA, electric vehicles have simply lacked enough range to be viable until recently. New advancements may change that, but the rise of Uber and Lyft may have made it too late. [51]	Ride hailing services have upended the taxi industry. **Taxi usage has fallen 75%** since 2012 when Uber first launched and Taxis made up just 22% of airport rides in 2019. The grip on travel the industry once had is gone and seems doubtful to recover.[52]	Electrifying the taxi industry might finally be possible with long range EV's, but the **business case** will need to be accompanied by other reforms that bring taxis the ease and accessibility of TNC's. The passing of Proposition 22 in California, which exempts TNCs from some labor laws, could spell the end of the taxi industry.

[48] https://policyinstitute.ucdavis.edu/wp-content/uploads/TNC-Electrification_May2020-v2.pdf

[49] https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions

[50] https://policyinstitute.ucdavis.edu/wp-content/uploads/TNC-Electrification_May2020-v2.pdf

[51] https://www.wired.com/2010/10/electric-taxis-comin-to-california/

Fleet Type	Stakeholder	Goals and Context	Market Analysis	Challenges and Opportunities
Medium Duty	Delivery Vehicles	Los Angeles has set a goal of **100% electrification** of urban delivery vehicles by 2035, while the California as a whole is **targeting 2040**[53]. California also offers incentive packages for trucks through the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP), and large utilities like PG&E and SCE have invested considerably in charging methods and build out for those looking to adopt.	The delivery van market has taken center stage during the COVID-19 pandemic, with package deliveries (and their corresponding emissions) soaring to all-time highs. The existing market has primarily concentrated on van and vehicle conversions, replacing ICE engines with electrified drivetrains. But recently, major players like Amazon and Ford have **announced electrified vans**, and consumers have bought their appeal.	The largest challenges (and opportunities) in fleet come not in vehicles but the **charging and management**. Stakeholders will want to minimize fuel costs and avoid the installation of expensive DCFC wherever possible, all while charging during off peak hours. Other secondary opportunities likely involve **improved grid resilience**. While vehicle-to-building grid connections are early, the ability for a building to continue operations despite grid issues likely has a considerable market. The dangers of wildfires and the preventative power shutoffs used to mitigate them magnify this need.
	Trash/ Refuse Trucks	Much like delivery vans, the existing market for trash trucks is a mix of conversions a special made trucks for select consumers; fortunately, many of those consumers are on the West Coast. The aforementioned California truck regulations will also **mandate the electrification** of new vehicles in phases by 2035 and 2040. Los Angeles has set goals of 2028, beginning purchases by 2022, while Sacramento started replacing diesel trucks that got just 2.8 MPG in 2017[54].	Garbage trucks have been identified as a perfect fit for EV charging cycles, but strains placed on the battery by both **mileage and compacting** have left some cities wanting. Others cities have been hesitant due to **high upfront costs**, but new regulations will likely make that point moot. Oregon, meanwhile, has not publicly established a strategy but is a cultural and geographic fit for adopting these technologies.	The chief issues facing these vehicles is **range and costs**, which further technological advancements should soften. In the meantime, methods of boosting the secondary benefits and trimming costs through **proper grid integration** will improve the business case for these vehicles.

[52] https://www.nytimes.com/2020/01/12/business/los-angeles-taxis-uber-lyft.html

[53] https://ww2.arb.ca.gov/news/california-takes-bold-step-reduce-truck-pollution

[54] https://www.prnewswire.com/news-releases/californias-first-all-electric-garbage-truck-headed-to-sacramento-equipped-with-motiv-all-electric-powertrain-300472737.html

Fleet Type	Stakeholder	Goals and Context	Market Analysis	Challenges and Opportunities
Heavy Duty	All	Heavy-duty trucks are in the **earliest stages of electrification** everywhere; America is no different. Despite the aforementioned and extremely ambitious requirements California has placed on manufacturers, the use of ZEV trucks is primarily limited to pilots and demonstration projects. The other **limiting factor is charging**: most incentive programs are only applicable to public charging, so limited support is available for the creation of private charging depots that will likely be necessary to support truck electrification.	Those interested in helping California electrify would do well to pay attention in the near future. The most promising market in the near term is **drayage trucks**, which have limited routes due to their routes between ports and distribution centers. Current drayage trucks, being built jointly by Toyota and Kenworth, function on hydrogen fuel cell technology and have been operating in the Ports of Los Angeles and Long Beach since 2017[55]. **Battery powered trucks** have a chance as well. Drayage truck solicitations began in August 2020 for Los Angeles area, funded by proceeds from the Volkswagen emissions scandal.[56] Other places, such as the Port of Oakland, are open to the idea but have found them unviable in the near term.[57]	There are many opportunities in the heavy-duty truck segment, from building reliable charging depots to navigating the regulatory process and managing renewable fuel credits that result from these trucks. All that matters first is **bringing a commercially viable truck to the market**. Charging in particular will prove an especially large challenge. The costs of **building charging depots** full of high kilowatt chargers will rely on savvy business models and accurate projections of energy throughput. **Ports** continue to be the most promising avenue for near term development. Over 40% of America's goods flow through the Los Angeles area ports, so throughput is consistent. Combined with clean air requirements imposed on LA, no place needs these vehicles more.

[55] https://www.reutersevents.com/supplychain/technology/toyota-and-kenworth-launch-first-10-zero-emission-fuel-cell-trucks-la-ports

[56] http://www.aqmd.gov/docs/default-source/vw_mitigation/vw-ze-faq.pdf?sfvrsn=9

[57] https://www.portofoakland.com/files/PDF/Zero%20Emissions%20Truck%20Feasibility%20Study%20Final.pdf

Fleet Type	Stakeholder	Goals and Context	Market Analysis	Challenges and Opportunities
Buses	All	While every city and state has different near-and-long-term goals for electrifying their school and transit buses, there is no question **that bus electrification is ahead** of similar sized vehicles. Both California and Oregon have put significant numbers of electrified buses into service, with California **mandating electrification** in new buses by 2029 and **all buses by 2040**. Simply put, the use-cycles and returns for these high mileage and high maintenance vehicles make electrifying too logical.	This is a market that is **well on its way to full commercialization**. The City of Sacramento already uses nearly 60 electric buses and will continue to build its fleet, while Los Angeles made the largest EV bus purchase in history in November 2019.[58] At the heart of this is dedicated manufacturers, many with presences in California like BYD and Proterra, who consistently produce quality products and offer other essential services like fleet planning.	Charging and vehicle acquisition, supported by government programs, has helped move this area into commercial territory. Competing with established bus brands and their corresponding chargers is a busy marketplace. Instead, future opportunities in the bus space likely revolve around **vehicle-to-grid backup**, and how utilities, school districts, and other stakeholders decide to **utilize dozens of empty buses during the middle of the school day**.
Other	Zero Emission Port Equipment	California's ports still rely heavily on manual labor, and political and economic pressures have and will continue to prevent widespread automation from taking place. Nonetheless, ports around California **aim to electrify as much as possible** in the next decade. A major part of the LA Green New Deal is to electrify the Port of Los Angeles, including its on-dock equipment, to cut total emissions by 80% by 2050[59]. Other ports, such as Long Beach and Oakland, have also begun electrification efforts.	The port equipment market is diverse, and its maturity depends on **the types of equipment** used. A number of products, like cranes and lifts, have been hybridized but not fully electrified. Others, like on and off dock tractors, have fully electric options.[60] The Port of Long Beach is already converting entire terminals to electricity, through a mixture of new equipment purchases and repowering.[61]	As is the case with most electric alternatives, **high capital costs** pose a significant obstacle (though existing government incentives fix that). Other barriers include simply providing enough **power** to power an entire commercial port without driving costs too high. Port workload can vary dramatically day by day, and electric equipment must be prepared to handle surges in workload. Much like buses and charging, partners could benefit from **a full-service suite** that demonstrates how to take advantage of off-peak hours through methods such as a battery buffer.

[58] https://www.cnet.com/roadshow/news/

[59] https://plan.lamayor.org/sites/default/files/pLAn_2019_final.pdf

[60] https://www.portofoakland.com/files/PDF/AECOM%20Zero%20emission%20CHE%20feasibility%20assessment%20Nov%202019.pdf

[61] https://www.polb.com/environment/our-zero-emissions-future/#program-details

6. Conclusions

Following the market analysis in the previous chapters, we provide several concrete opportunities for Dutch organizations. In facilitating the upscaling of a charging infrastructure that is accessible and affordable for all, we believe that Dutch experience and knowhow can contribute significantly to the Californian market. The following conclusions are found on the basis of literature and stakeholder interviews.

6.1 Policies in place make room for investment

The available information shows that the state of California is doing very well when it comes to EV policies, ambitions and targets. California sees electrification as one of the main means for the decarbonization of transport in the state. Grants and financing are well in place, so there are considerable opportunities for support. These are available to existing and new market entrants alike, as well as to foreign companies (though many grant processes require a US presence).

These pro-EV policies ensure subsidies are invested in electric mobility and encourage private investments. However, there are still several obstacles that prevent EV from upscaling and so prevent California from realizing its most ambitious policy goals. Dutch companies can play an important role in taking away such barriers. These investments, however, must be tailored to serve the unique Californian context: the abundance of single-family homes and absence of public transportation, older MUDs with potential electricity issues, an overall old infrastructure, and demands for convenience.

Government and commercial actors are likely the best place to begin with new VGI and charging technologies, because these actors pay more attention to the fiscal benefits than individuals.

6.2 Help to increase awareness, collaboration and knowledge

One of the prerequisites for a successful EV adoption rate is EV awareness. This awareness is currently relatively low and California needs to improve it to reach its targets. New knowledge, collaboration efforts, and even business models would play a large role in making electric vehicle charging accessible and affordable for all.

Raising EV awareness itself in California is a hard task for Dutch organizations to achieve, but they can help in several ways that were brought forward by Californian stakeholders. These include developing smart(er) procurement, new collaborations, and clever financing through initiating and intensifying public-private partnerships[62]. Applying the 'target group approach' from the electrification of several different vehicle types (fleet groups) in the Netherlands (e.g. the electrification of taxi's at Schiphol airport, electrification of locally managed Special Transport Services) could be successful in California. Using creative ways of collaborating with different stakeholders is essential; this will help to create the necessary trust and confidence in both parties. Bringing together public and private interests requires coordination. Dutch organizations are good at this and consultancy services can add value here as well. Such smart collaborations will also help to increase EV knowledge and awareness, as resources can be combined.

Lessons learned from past years (linked to the S4C program) confirm that public private partnerships and a combination of soft and hard agreements enable acceleration within the EV value chain. For example, in Amsterdam the local government differentiates between (usually private) charging hubs outside the

[62] C2C Webinar 18 November 2020: How to accelerate charging infrastructure deployment?

city and tries to match this to the (usually public) charging infrastructure offered within the city. Combining this with strategic locations and data driven deployment, this leads to a robust and balanced charging network. Such a strategy does not exist in California. This asks for smart collaboration in (communication) strategies as well as data sharing. This is where Dutch experience in public private (smart) collaboration and financing can contribute to the Californian EV acceleration.

From the interviews, we find that, mainly due to relatively low awareness and experience in EV, fleet owners are in need of a full-service suite (all-in service), inclusive of vehicles, education and training, and repair services. The same goes for medium and heavy-duty vehicles, where charging management and installation can add further value. This again shows the importance of smart procurement and collaboration: to discover which products and services are essential and to match demand accordingly. On the supply side, companies who complement each other's product or services could partner, becoming more attractive as they are able to offer a full-service suite.

6.3 Concrete solutions for charging infrastructure and VGI

Another prerequisite for successful electric mobility is to have access to concrete and proven solutions for both charging infrastructure and Vehicle Grid Integration (VGI). Such solutions can be chargers or charger installations themselves, but also a clear plan on how to deploy charging infrastructure in an efficient manner. This is especially true for specific situations like MUD neighborhoods and other shared private charging and heavy-duty charging solutions. The Dutch experience with data driven deployment of charging infrastructure could prove to work very well in California. It gives room for installing chargers efficiently and at an affordable rate.

In the deployment of charging infrastructure, collaboration is key. The California Energy Commission confirms that "for an installation project, permitting and coordination with the utility can impact the timeline. Such impacts vary by jurisdiction, and a charging provider should coordinate with utilities and local authorities early in the project planning phase. Especially for fast charging, the distribution grid may need an upgrade that could prove expensive and take significant time. This situation will apply to many medium and heavy-duty vehicle charging sites, and poses a significant barrier. In some cases, emerging technologies such as battery-backed charging systems can alleviate grid or space constraints, especially as time passes and these technologies further mature and become more economically viable." Current difficulties in scaling up include the need for coordination among manufacturers and other entities and site host/customer awareness of solutions that fit their charging needs. Showing that feasible solutions exist and being able to work with clients and partners throughout all project phases will help to get a foothold in the Californian market.

In addition, creative and alternative charging solutions for 'regular' charging infrastructure in dense urban areas are very welcome in American cities. Dutch experience and examples could help, including the use of multifunctional objects like integrating chargers with street lights or public bins (containers), charging hubs in which several chargers are clustered, underground charging, or using the same grid connection for more and different applications.

Also in the realm of VGI, Californian stakeholders share their need for innovative solutions. Current challenges for VGI include the lack of adequate communication technologies, like technology to set charge times at the charger or EV, or technology to communicate billing information from charger or EV to the utility. Protocols such as OCPP and OCPI originate from the Netherlands, showing that solutions are being developed and implemented. As such, it makes sense to apply these communication technologies to California. It is important to show that such solutions also work well in the American context, so smooth implementation can be guaranteed.

7. Recommendations

Recommendations follow the conclusions in the previous chapter. When you consider investing in the Californian EV-market as a Dutch EV-company, what should you pay attention to? These steps are recommended.

7.1 Work together instead of trying alone

The Californian EV market has as many challenges as opportunities, and it is open to new solutions and new investments. But to take advantage of this and to use your full potential, we strongly recommend finding local partners with whom to enter (or re-enter) the market. Being in a partnership provides more opportunities to leverage existing financing or grants, it makes it easier to offer full-service suites, and makes it possible to serve a broader range of clients. Further, having a local partner also helps navigate the challenges posed by companies that many not have the US presence that is sometimes required for government support, grants, or bids.

In addition, we recommend looking for a two-way street where possible: finding American counterparts that are interested in the European market can help accelerate growth and mutual understanding about entering a new market as a business. Several partnership programs (like S4C) and organizations specialize in setting up stakeholder meetings and partners.

7.2 Show that your solution works in the US

It is important to show American EV stakeholders that your solution works in the American context; that means Americanizing your solution to both conditions, such as different legal frameworks, and expectations. Build a showcase or get involved in a pilot project so you can show your future American clients that your product or service is worthwhile in the US. The best examples or projects would help dictate the future of charging and VGI in California and America. High profile pilot projects aim to contribute to the mainstream appeal in the general public. When linked to a local building or neighborhood, it further draws positive public attention and the performance will attract others. Imagine a smart charging project using EV batteries at the San Francisco 49ers home stadium!

It is also important to examine the stakeholders that will be involved in solving each challenge: utilities for grid management pilots, location owners for charging infrastructure deployment strategies, and EV-users for showcasing easy-to-use phone applications or drivers' experiences. We recommend focusing in the short term on products and services that are on the brink of upscaling, to increase market success.

7.3 Build a network and connect with possible clients

It is essential for foreign success to build your own network to connect with possible clients. It is of utmost importance to be visible to your prospective clients, since only “being able to do the job is not enough.” Build a solid sales and marketing strategy to show why you should be the one to do the job. For this, local partners or partnership programs (see 7.1) will help to engage in smart procurement and to put you in touch with possible clients for your product or service. Do sign up for “opportunities lists” to be kept up to date (see chapter 8).

For Dutch companies, it is recommended to actively approach American organizations. In the Netherlands, venture capital is hard to find, whereas in the US it may be the best option to enable acceleration. It also allows them to make use of the “two-way street” and also enter European markets. Empowering such investments starts by getting in the picture. It is recommended to specifically approach certain prospective clients and concentrate one’s resources. Make use of the underserved parts of the American EV-market mentioned throughout the document, and show that you know how it works. Such areas include charging for MUDs, but also ride share fleets that need consolidated places to charge, or warehouses that are currently being built and need to be compatible with VGI for fully electric delivery vehicles (this area is especially important with e-commerce's rise during the COVID pandemic).

8. Tips & tricks

In addition to the recommendations in the previous chapter, this chapter offers some extra information and tips & tricks to make your way in the Californian electromobility market.

Doing business in California

- US presence and/or very good relationships with American organizations are an advantage to navigating bureaucracies, permitting and grant processes and generally a new environment. Make sure to invest in building up trust and to work with local partners. Get in touch with organizations like S4C, Californian Mobility Centre or Forth Mobility to help you find the right partner.
- Local governments in California seem quite pro-active in looking for new opportunities. Ensure you get in touch with them to start with demonstration projects and talk about budgets for innovative projects.
- Only technologies with demonstrated success in North America will be applied. Products need to be certified for the North American market.
- Be sure to speak with counterparts at the right level. Budget responsibilities are often kept at a higher director level than in the Netherlands.
- Sign up for "opportunities list servers" (also known as "ListServs") to be kept up to date about new grants, financing and subsidies or invitations to tender. Several options are listed in the appendix section 8.2 under Grants.

The energy market structure

The energy market in the US works differently than in the European energy market. The US market relies on independent system operators (ISO), centralized dispatch, co-optimization of reserves and nodal pricing. In Europe, the model is based on transmission system operators (TSO), self-dispatch, separate reserves procurement and zonal pricing. Concerning smart charging or VGI, this may have consequences for trading electricity and flexibility. Be aware that not all aspects are set in stone yet, for example whether a third-party owner of charging facilities is regulated differently than a utility or not at all. This could create a competitive bias. It is expected that in the next couple of years legislatures will have to step in for clarity.

Imperial system

Be aware that the US uses the imperial system and not the metric system that is used in Europe. This may affect parts of products, vehicles or infrastructure to be delivered and used in the US.

Grid voltage

The voltage of the US power grid is a nominal 120 volts, which is significantly lower than the 230 volts of Europe's power grid. This implies that, for level 2 chargers or faster chargers, often a dedicated higher voltage circuit needs to be installed.

Be there for you

The Netherlands Consulate General in San Francisco has vast experience with doing business in California. In case you are planning to do business, it might help you with contacts, cultural insights and knowledge about general aspects of California and the US. The consulate is very interested to hear from Dutch organizations willing to discover California and is there for you to help.

For questions and information please send an email to sfn@minbuza.nl

Appendices

Appendices

8.1 Stakeholder information and definitions

The different stakeholders in the EV playing field in California are provided in the next paragraphs.

State Government of California

The Governor's Office of Business and Economic Development (GO-Biz) – GO-Biz serves as a starting point for businesses aiming to base themselves or employ workers in California. Inside GO-Biz is the Zero Emission Vehicle (ZEV) Market Development Unit, who serve as points of contact for ZEV related companies hoping to help California advance its clean transportation goals in all forms. The team, though small and often overworked, is an excellent resource for contacts in other agencies and parts of the government.

California Energy Commission (CEC) – The CEC is one of the largest sources of public funding for charging infrastructure in California. Through the Commission's Clean Transportation Program (CTP), the CEC invests tens of millions of dollars in zero-emission vehicle infrastructure. The principal method for light-duty charging is the California Electric Vehicle Infrastructure Project (CALeVIP), a rebate-based program that reimburses station developers for certain costs associated with charger building (but only after the project has been built out). The CEC also houses a lot of the data and planning for EV charger buildout.

California Air Resources Board (CARB) – CARB is almost certainly the most powerful regulator in the state of California, responsible for administering clean vehicle rebates, light and heavy vehicle emission regulations.

California Public Utilities Commission (CPUC or PUC) – The CPUC is the principal regulator for many industries in California, ranging from telecommunications to transportation. Most relevantly, it regulates the state's Investor-Owned Utilities (IOUs) who provide much of the state's electric and natural gas. Those IOU's include Pacific Gas & Electric (PG&E), Southern California Edison (Edison or SCE), and San Diego Gas & Electric (SDG&E) as the largest players.

Californian Cities, Counties, and Their Respective Transit Agencies

Municipal and local governments are often some of the first stakeholders to begin adopting zero-emission technologies; due to both constituent pressure and the cost savings ZEVs can bring in the right conditions. The city of Sacramento has a city ZEV fleet, as do many others in the Clean Cities Coalition Network (Clean Cities is a US Department of Energy that provides resources and information to cities to help advance alternative fuel vehicles).

Local transit agencies (and other semi-governmental organizations) are under pressure to electrify quickly. CARB has passed regulations requiring an entirely zero-emission public bus fleet by 2040.

Californian Utilities

Utilities in California fall into a couple of categories, as described below:

Investor-Owned Utilities (IOUs) – IOU's, mentioned above, comprise the largest and most powerful electrical utilities in the state. They are heavily regulated, and all actions must pass through the CPUC's regulatory process before beginning to ensure unfair costs are not passed onto California consumers (who already pay the highest electricity costs in the USA). The three largest utilities (Pacific Gas & Electric (PGE), San Diego Gas & Electric (SDGE), and Southern California Edison (SCE)) are currently approved to commit over a billion dollars in transportation

electrification investments in the coming years, with specific targets (details in the Draft Transportation Electrification Framework and related documents). Significant portions of those investments are targeted at previously hard to reach areas, such as minority and low-income communities or those living in multi-unit dwellings (such as apartments). The IOUs can also invest in workplace and fast charging, as well as heavy-duty vehicle charging.

Publicly Owned Utilities (POUs) – POUs comprise a significantly smaller market share than IOUs but are worth mentioning because they service both the state's Capital (Sacramento Municipal Utility District) and parts of Los Angeles (LA Department of Water and Power). They have more flexibility (but less resources) than their IOU counterparts.

All the utilities offer discounts on electricity rates for EV drivers in their jurisdiction, and most offer discounts on new EV purchases (many offer rebates for used EVs as well).

Private Charging Companies

Private EV charging companies do the bulk of public EV charger development in California. The chart below displays the distribution (approximated) of capital costs borne by each player. The primary players include building out public charging stations **Tesla, Electrify America,** and **EVGo.** These companies generate revenue based on operating charging stations by leasing parts of property. Other companies like **Chargepoint**, not listed, provide the physical charger, and software, but do not bear the costs of installing the charger (nor do they generate revenue based on usage). An important part of these companies' business models is the Low Carbon Fuel Standard program, which awards credits for lower carbon fuels distributed (which are sold to oil and gas producers to offset, essentially acting as a mobile fuel-based Cap and Trade program. More details can be found here).

EV stakeholders in Portland

In Portland, Oregon, there are similar organizations that are active in the field of EV, including the State Government of Oregon, the Oregon Department of Energy, the Oregon Department of Environmental Quality, the Oregon Department of Transportation, the City of Portland, the Oregon Public Utilities Commission and Oregonian utilities including both POUs and IOUs.

8.2 Useful documents and websites

In this section, several useful documents and websites are shared for reference.

Organizations

- *California Mobility Center (CMC)*
  The CMC orchestrates commercially meaningful interactions between future mobility start-ups and industry-leading members.
  https://californiamobilitycenter.org/

- *University of California, Los Angeles Luskin Center for Innovation (LCI)*
  The LCI conducts rigorous research and timely outreach that informs environmental policies. They evaluate existing and proposed environmental policies to assess their effectiveness, equity impacts, and potential to spur innovation. Research findings are shared with community leaders and policymakers, who use them to design evidence-based environmental policies.
  https://innovation.luskin.ucla.edu/

- *University of California, Davis Center for Sustainable Transportation*
  https://ncst.ucdavis.edu/

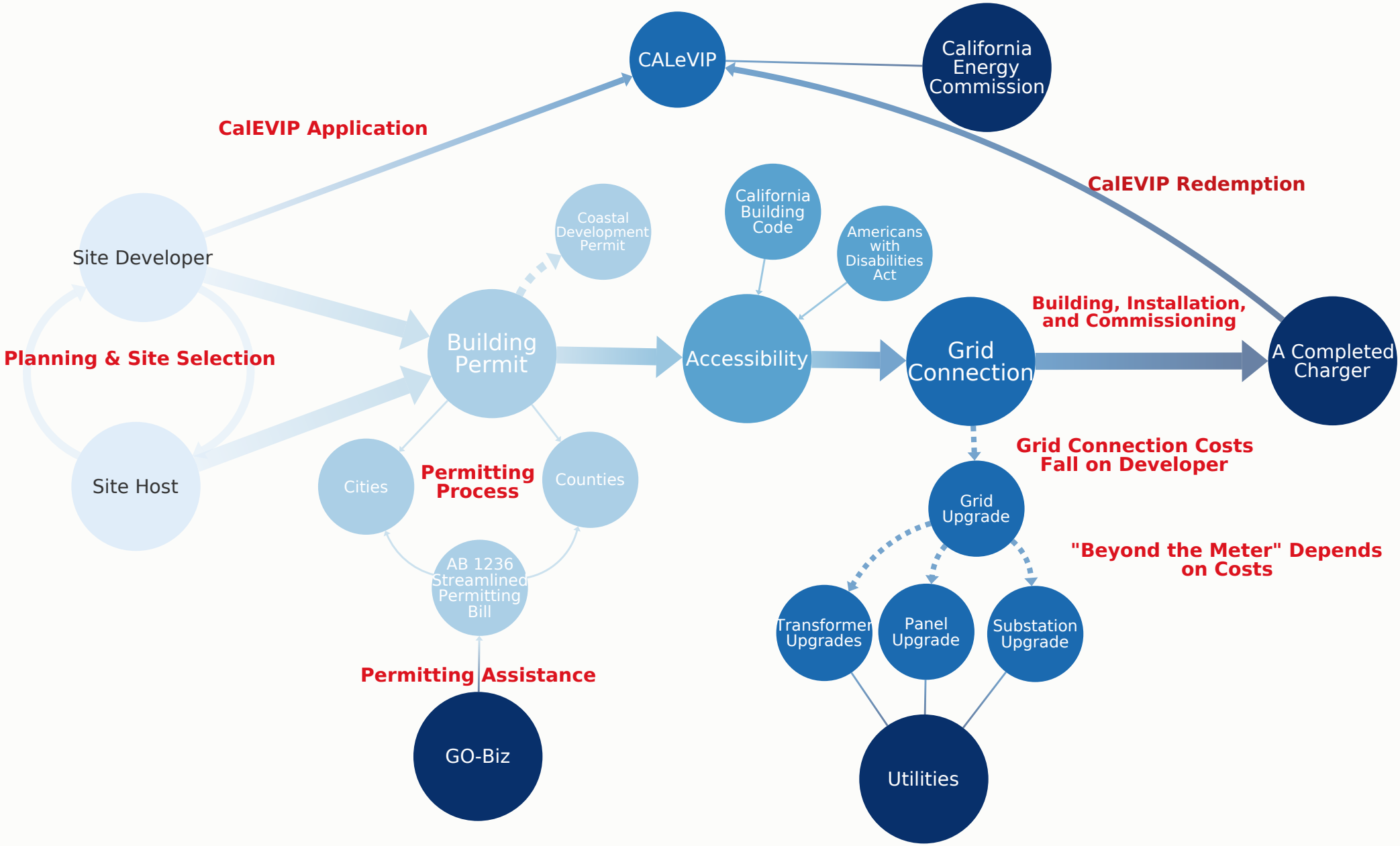
Grants

- California Energy Commission Solicitations (Grant Opportunities) can be found at https://www.energy.ca.gov/funding-opportunities/solicitations
- California Air Resources Board Solicitations: Low Carbon Transportation Investments and AQIP Grant Solicitations can be found at https://ww2.arb.ca.gov/our-work/programs/low-carbon-transportation-investments-and-air-quality-improvement-program/low

- South Coast Air Quality Management District (AQMD) Grants can be found at http://www.aqmd.gov/nav/grants-bids

- Bay Area AQMD Grants can be found at https://www.baaqmd.gov/funding-and-incentives/businesses-and-fleets

How an EV Charger Gets Built



COLOPHON

This report is an analysis of the EV-market in California and selected cities with a special focus on charging infrastructure, smart charging (vehicle grid integration), fleets and EV-knowledge and strategy.

This report was written up on behalf of the Netherlands Consulate General in San Francisco, as a closing part of the Coast2Coast program.

We thank all of our contacts and stakeholders that have contributed to this research through participating in an interview or by providing written answers to our questions.

APPM Management Consultants

www.appmworks.com

www.appm.nl

This is a publication of
Netherlands Enterprise Agency
Prinses Beatrixlaan 2
PO Box 93144 | 2509 AC The Hague
T +31 (0) 88 042 42 42
E klantcontact@rvo.nl
www.rvo.nl

This publication was commissioned by the ministry of Foreign Affairs

Publication number: RVO-007-2021/RP-INT

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for Agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.