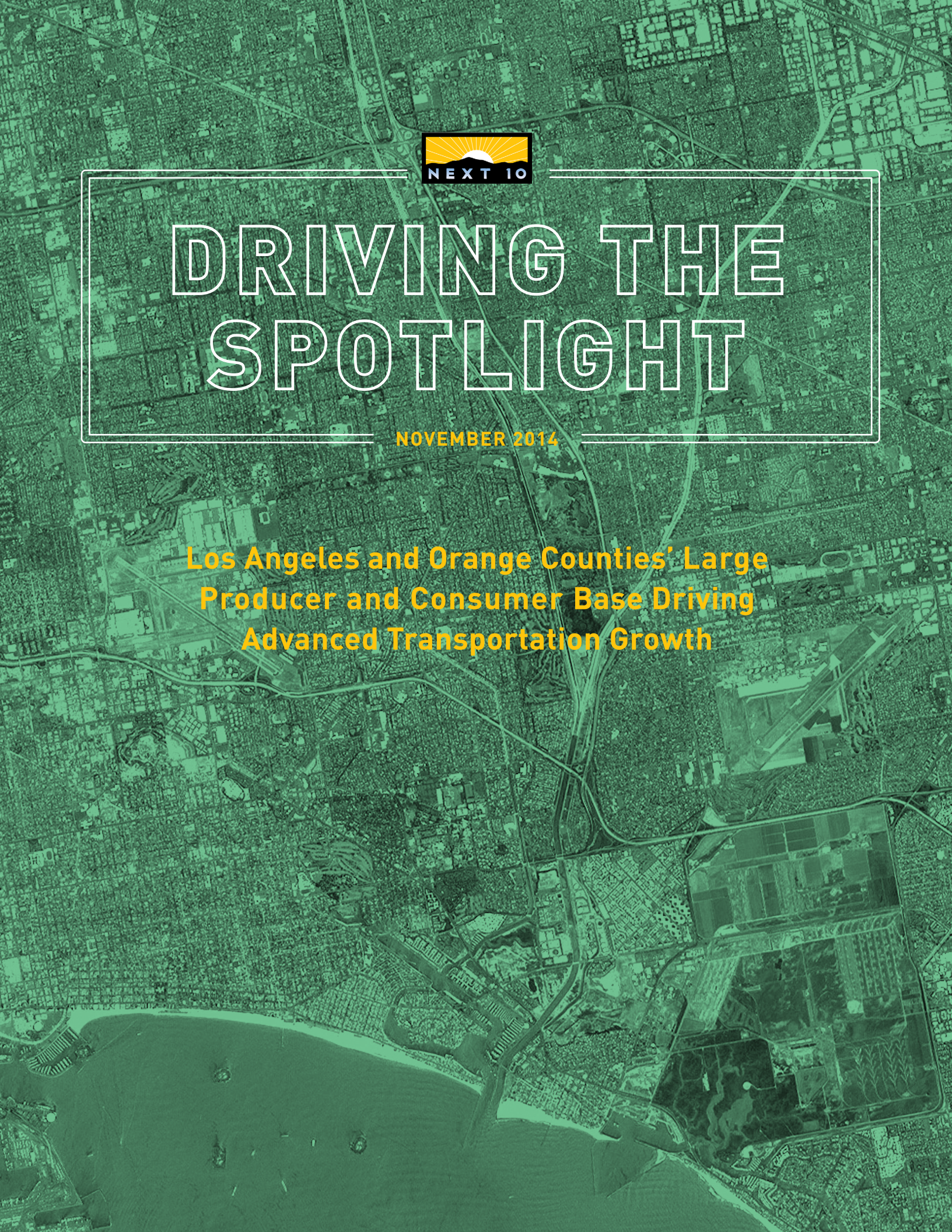

NEXT 10

DRIVING THE SPOTLIGHT

NOVEMBER 2014

Los Angeles and Orange Counties' Large Producer and Consumer Base Driving Advanced Transportation Growth

ACKNOWLEDGEMENTS

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Next 10 is an independent nonpartisan organization that educates, engages and empowers Californians to improve the state's future.

Next 10 is focused on innovation and the intersection between the economy, the environment, and quality of life issues for all Californians. We provide critical data to help inform the state's efforts to grow the economy and reduce global warming emissions. Next 10 was founded in 2003 by businessman and philanthropist F. Noel Perry.

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ABOUT THIS REGIONAL CLEAN ECONOMY SERIES

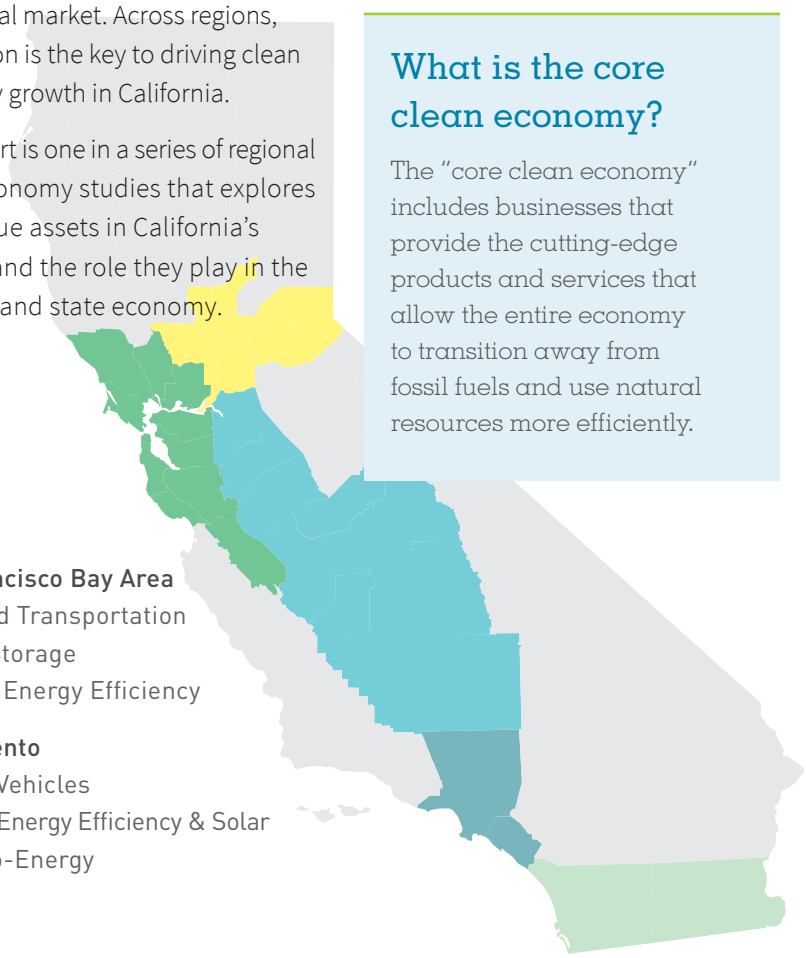
California is a national leader in the clean economy, with companies pushing the envelope developing and deploying clean technologies, spurred by progressive state policies stimulating company growth. As a result, the core clean economy has become an important driver of California's overall economic vitality, employing over 185,000 workers as of January 2014 while protecting the state's natural resources.

California's statewide economy is comprised of regional economies, each with distinct assets and strengths. Regional stakeholders are leveraging their unique assets in innovative ways to develop and expand clean technologies within their region, with potential applications in the broader state and global market. Across regions, innovation is the key to driving clean economy growth in California.

This report is one in a series of regional clean economy studies that explores the unique assets in California's regions and the role they play in the regional and state economy.

What is the core clean economy?

The "core clean economy" includes businesses that provide the cutting-edge products and services that allow the entire economy to transition away from fossil fuels and use natural resources more efficiently.



San Joaquin Valley
Water-Agriculture
Renewable Energy

San Diego - Imperial
Smart Grid
Biorenewables

Los Angeles & Orange
Advanced Transportation

San Francisco Bay Area
Advanced Transportation
Energy Storage
Building Energy Efficiency

Sacramento
Electric Vehicles
Building Energy Efficiency & Solar
Waste-to-Energy

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EXECUTIVE SUMMARY

As the region with the largest consumer base in the state, the Los Angeles-Orange County region is leveraging its large population to foster a supportive environment for the development and deployment of advanced transportation technologies. This report explores Los Angeles and Orange Counties' unique assets that are driving innovations in the advanced transportation sector. These innovations include both the development and creation of new technologies and companies, as well as the application and deployment of clean technologies in new ways. This report is based on new data analysis and interviews with regional stakeholders who identified advanced transportation as an emerging area in which local companies as well as public and private organizations are increasingly active.

Highlights from this report include:

- **The region is leveraging its large population and anchor industries** to increase development and deployment of advanced transportation technologies for its local consumer base and global markets. The regional advanced transportation sector incorporates a range of technologies, including vehicle technologies such as electric and hydrogen fuel cells; alternative fuels such as compressed natural gas (CNG) and renewable natural gas derived from waste; energy storage; and smart grid.
- **Los Angeles and Orange Counties represent the largest and fastest-growing electric vehicle market in the state,** with about 23,500 total electric vehicles registered in 2013, nearly double the amount from 2012. Natural gas vehicles are also growing in the region, with about 16,000 registered in 2013, nearly half of the state total.
- **Regional companies are forming innovative partnerships to drive advanced vehicle technology adoption.** A number of companies are working with local transit agencies and the Ports of Los Angeles and Long Beach, as well as the general public, to drive technology adoption. These companies are developing, testing, and implementing new vehicle technologies, as well as installing electric vehicle charging stations and natural gas infrastructure.
- **Innovation in advanced transportation is increasing in the region.** The region is home to over 20 automotive design centers, as well as research universities, large corporations, and startup companies that are developing new advanced transportation technologies. Regional inventors registered 154 advanced transportation patents in the 2012-2013 time period, more than twice the amount in the 2002-2003 period.
- **Regional collaborations are supporting sector-wide growth,** including public-private partnerships with local economic development and workforce groups, as well as innovation centers such as incubators and universities.

INTRODUCTION TO LOS ANGELES AND ORANGE COUNTIES' CLEAN ECONOMY

The Los Angeles-Orange County area is mobilizing regional assets to grow its clean economy. The region is leveraging its large population and anchor industries to accelerate development and deployment of clean technologies in areas ranging from renewable energy to electric vehicles. These efforts are helping the region both meet demand for clean technology products and services within its large local consumer base, and develop new clean technology innovations with global applications.

As a dense population center, the region has unique scaling and deployment opportunities in clean, efficient technologies. The region is home to a large clean technology consumer base, both because of its large population as well as its culture of sustainability and early technology adoption. In 2013, the Los Angeles-Orange County area's population accounted for 34 percent of the state's population, with over 13 million residents and rising. Local strengths such as leading academic institutions, a diverse economic base in aerospace and defense, goods movement and logistics, and tourism and hospitality, as well as its strong ties to global markets, have positioned the region to be a leader in producing and demonstrating new clean technologies. The Ports of Los Angeles and Long Beach, for example, are two of the busiest ports in the world, and are instrumental for testing new innovations as well as providing easy access to a global market for clean technology innovations. clean economy.

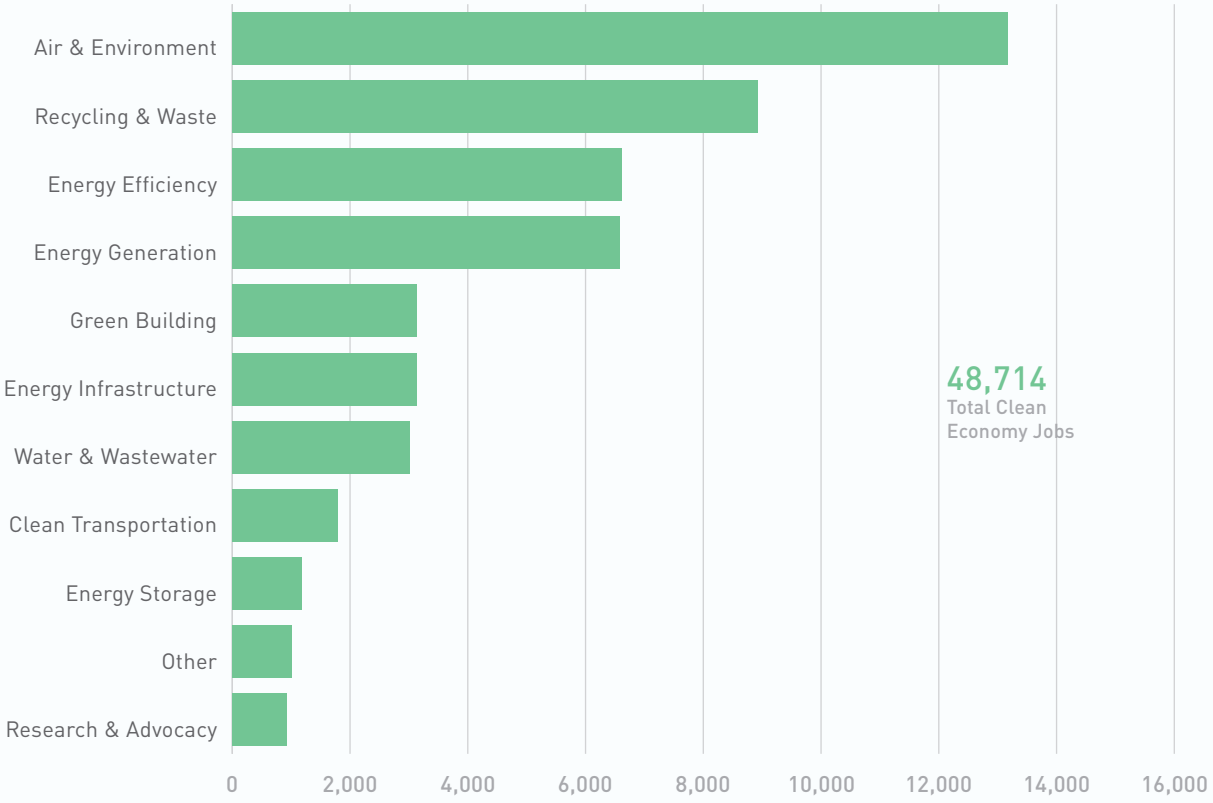
The region is pursuing a broad range of clean technologies and is emerging as a leader in the growing advanced transportation sector. This report explores how stakeholders in Los Angeles and Orange Counties are leveraging their unique assets and accelerating advanced transportation innovation in the region. Growth in this sector is bolstered by numerous collaborations, spanning businesses, academic institutions, municipal and county governments, and economic development organizations. Stakeholders are creating policies and programs to connect and mobilize key players to grow the advanced transportation consumer base and export markets in the region.

What unique assets drive the region's clean economy?

Los Angeles and Orange Counties have the largest consumer base in the state, as well as a high concentration of business consumers of transportation technologies such as the ports and public transit agencies. The region is leveraging this local demand to develop and deploy advanced transportation technologies and to serve broader state and global markets.

The region is the automotive design capital of the world and is the largest manufacturing center in the U.S., which gives the region a competitive advantage in the advanced transportation market.

Figure 1: Core Clean Economy Jobs, Los Angeles and Orange Counties, 2014



As of January 2014, there were nearly 49,000 jobs in Los Angeles and Orange Counties' overall "core" clean economy. These core jobs are in a range of businesses that provide the products and services that allow the entire economy to transition away from fossil fuels and improve efficiencies in the use of natural resources.

Employment in the region's clean economy is largely comprised of the Air & Environment and Recycling & Waste segments, though the region's clean economy includes a wide range of sectors and activities. This report focuses on the segments of the clean economy that are driving innovation in the region, both in terms of new technologies and deployment strategies. For a more in-depth analysis of overall employment data in the clean economy, see Next 10's *California Green Innovation Index,* which tracks the clean economy statewide and includes an analysis of the fifteen segments of the clean economy.

NOTE: "Other" includes Advanced Materials, Clean Industrial Support, Agricultural Support, Business Services, and Finance & Investment segments.
SOURCE: National Establishment Time Series, Green Establishments Database.
ANALYSIS: Collaborative Economics

DRIVING GROWTH IN ADVANCED TRANSPORTATION

Los Angeles and Orange Counties' advanced transportation sector includes activities aimed both at meeting local demand and developing new technologies. The region has prioritized the advanced transportation cluster for a number of reasons, including the need to reduce air pollution (primarily from cars, diesel trucks, ships, and trains) and to capitalize on the opportunity for economic growth in the sector. In addition, growth in the sector contributes to state policy goals, such as the governor's goal to have 1.5 million zero emission vehicles (ZEVs) on the road by 2025 and Assembly Bill 32's mandate to reduce greenhouse gas emissions to 1990 levels by 2020. The regional advanced transportation sector incorporates a range of technologies, including vehicle technologies such as electric vehicles (EVs) and hydrogen fuel cells; alternative fuels such as compressed natural gas (CNG), liquid natural gas (LNG), and renewable natural gas derived from waste; energy storage; and smart grid.

Los Angeles and Orange Counties together accounted for 26 percent of all advanced transportation jobs in the state (over 11,000) as of January 2014.[1] These jobs include a robust mixture of start-up and established companies, working to add to the regional advanced transportation mix. These jobs are present throughout the value chain, including strong areas of research and development (R&D), installation and maintenance of products, and manufacturing.

Implementing and Scaling Advanced Transportation Technologies

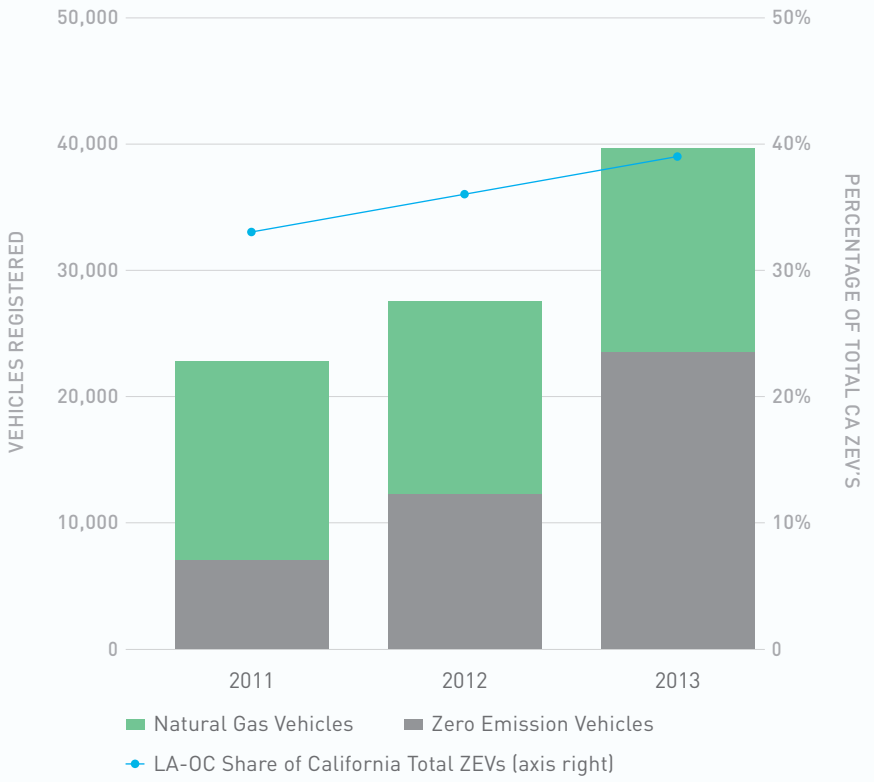
Los Angeles and Orange Counties are making strides in deploying advanced transportation technologies, including vehicles, charging and fueling infrastructure, and supportive products and services, such as software applications. Adoption of new technologies like electric vehicles is creating a need for other services, such as charging infrastructure, and companies and regional organizations are working together to develop solutions to enable wide-scale adoption of electric vehicles. Given its large population size, the region is the ideal testing ground for the sector to scale up new advanced transportation products and services.

Advanced Transportation in Los Angeles and Orange Counties

Regional companies, public and private organizations, and other stakeholders are accelerating advanced transportation innovation in the area to serve the local consumer base and the global market.

The advanced transportation sector in the region includes a range of technologies, including vehicle technologies such as electric and hydrogen fuel cells; alternative fuels such as compressed natural gas and renewable natural gas derived from waste; energy storage; and smart grid.

Figure 2: Total Zero Emission and Natural Gas Vehicles Registered in Los Angeles and Orange Counties



SOURCE: California Energy Commission. Zero emission vehicles include battery electric, plug-in hybrid electric, and hydrogen fuel cell vehicles.
ANALYSIS: Collaborative Economics

The region constitutes California's largest and fastest-growing ZEV market, including battery electric, plug-in hybrid electric, and hydrogen fuel cell vehicles. Los Angeles and Orange Counties registered about 23,500 total ZEVs in 2013, nearly double the amount from 2012 (Figure 2). About two-thirds of the 2013 registrations were in Los Angeles County (69%) with the remainder in Orange County, and each county grew registration rates by more than 90 percent from 2012. The region also reached a higher than average share of California's ZEVs, with 39 percent of the state's total ZEVs in 2013, compared to only 33 percent of total vehicle registrations.

Natural gas vehicles, a lower-emission vehicle compared to gasoline, are also growing in the region. Los Angeles and Orange Counties had about 16,000 natural gas vehicles registered in 2013, nearly half of the state total. Natural gas vehicle registrations have grown more slowly in recent years, up six percent between 2012 and 2013, and ZEV registrations surpassed natural gas vehicles in 2013 for the first time. This rapidly increasing regional market creates growing opportunities for businesses and the workforce.

Meeting Local Demand for Vehicles

Regional businesses are meeting local demand for advanced transportation vehicles. BYD Motors, for example, opened an electric bus manufacturing facility in Los Angeles County. In April 2014, BYD unveiled the first ever California-made all electric bus for the Antelope Valley Transit Authority, located in Northern Los Angeles County.[2] BYD Motors has also contracted with the Los Angeles County Metropolitan Transportation Authority (LA Metro) to deploy as many as 25 electric buses in the future. LA Metro's electric bus effort is part of the organization's continuing move towards cleaner transportation to achieve local health and environmental benefits, which included the conversion of much of its bus fleet from diesel to natural gas in 2011.

The goods movement and logistics industry is playing an important role in implementing advanced transportation technologies, motivated by the need to improve air quality and reduce fuel and maintenance costs. The Port of Los Angeles and Port of Long Beach have been key in enabling this transition and helping test innovative technologies that have the potential to transform the industry globally. Port efforts range from switching from diesel to CNG or LNG trucks and implementing software for increased efficiency at the ports, to shore power and off road cargo handling equipment advancements. Both Ports also have a Clean Truck program as a central element of their Clean Air Action Plan, which includes a progressive ban on trucks

LA County has the nation's busiest port complex, which serves as a vital driver of our local, state and national economies. The Ports of Los Angeles and Long Beach are committed to advanced transportation, and have demonstrated this by implementing a clean air action plan, investing in emerging technologies to improve emission reduction, and demonstrating new technologies with local companies.

– JoAnne Golden-Stewart, LAEDC

that do not meet increasingly stringent pollution standards.

The Ports are partnering with public and private stakeholders to pilot increasingly cleaner technologies. The Port of Long Beach, for example, launched a partnership in 2014 with multiple agencies to test an overhead "eHighway" system for powering short-haul transport trucks. The all-electric technology will be similar to cable car lines and is expected to be built along a 1-mile stretch in 2014 and tested in 2015. The Port of Long Beach is contributing $2 million to the $13.5 million project, in partnership with organizations such as the South Coast Air Quality Management District, the Port of Los Angeles, and the Southern California Association of Governments.[3] The Port of Los Angeles has multiple electric and hydrogen fuel cell truck pilot projects as well, including a partnership with the locally based electric truck manufacturer Balqon Corp. to test longer-haul heavy-duty electric trucks.[4] US Hybrid, a local company that specializes in designing and manufacturing electric and hybrid vehicle components, received a California Energy Commission grant in partnership with the Gas Technology Institute to develop and deploy two CNG plug-in hybrid trucks for drayage operations. The two-year demonstration project started in 2014.[5]

Implementing Supportive Infrastructure

In order to support advanced transportation deployment efforts, the region is ramping up installations of charging and fueling infrastructure as well. State and local public and private stakeholders are making investments in supporting infrastructure including electric charging and alternative fuel stations to accommodate the growing market. Los Angeles Department of Water and Power expanded their program Charge up LA! with $2 million dedicated for about 2,000 rebates between 2013 and 2015 for faster Level 2 chargers at home, work, and public spaces. Charge up LA! builds on their previous EV charger rebate programs that supported 500 residential charger installations in Los Angeles.[6]

Several local companies are emerging to develop, install, and maintain electric vehicle charging infrastructure. Aerovironment, for example, is a Los Angeles County-based company with diverse operations, including a business unit that develops EV charging systems for residential, commercial, and public stations. EV Connect is another local company that offers charging stations, installation services, and management software, and is increasingly active across the country. Clean Fuel Connection has both an EV charging and CNG fueling

infrastructure division, and has installed stations across California.

In Orange County, where the tourism industry drives significant economic activity, EV fast charging stations are now available at four of the county's prominent malls. To serve the ports and goods movement industry, companies like the Clean Energy are supporting clean truck initiatives in goods movement by providing LNG from a California-based LNG plant that will serve up to 8,000 trucks at the ports.[7] Clean Energy also recently opened a series of natural gas stations along Interstate-10 to serve the goods movement industry between Los Angeles and Houston.[8]

In addition, the region is ramping up efforts to create new hydrogen fuel stations in anticipation of an increase in hydrogen fuel cell vehicles. In 2014, Orange County-based FirstElement Fuel received over $27 million in a California Energy Commission grant to construct 19 stations across the state, including in the region.[9]

Regional collaborations are supporting this economic growth and preparing the local workforce for jobs in the sector.

Regional Collaborations to Accelerate Implementation

A strong network of supportive public and private organizations is playing an essential role in ensuring that the region captures the economic benefits from a growing advanced transportation sector. Regional collaborations are supporting this economic growth and preparing the local workforce for jobs in the sector. For example, local workforce investment boards, such as Pacific Gateway and Orange County Workforce Investment Board, are coordinating with businesses in the sector to identify needs and prepare local workers with the in-demand skills in advanced transportation.

Local colleges are key players in preparing the workforce as well. Rio Hondo Community College, for example, developed one of the nation's leading training programs in its Alternative Fuels & Advanced Transportation Technology Associate's Degree. This program emphasizes conversion to, installation of, and maintenance of electric vehicles, liquefied petroleum gas, compressed natural gas, hybrid fuel technologies, and related systems. The training curriculum is actively preparing the workforce in advanced transportation technologies, which is increasingly important as the market continues to grow.

Economic development groups, such as the Los Angeles Economic Development Corporation (LAEDC) and Orange County Business Council, are also facilitating regional collaborations to grow the sector. These two groups, along with Pacific Gateway and Orange County Workforce Investment Board, received a California Workforce Investment Board grant to develop the regional advanced transportation industry, working with employers and community partners to grow the sector. This regional partnership builds on existing advanced transportation efforts in the area. For example, since 2010, LAEDC's e4Mobility Alliance has brought together hundreds of stakeholders in the business, academic, workforce, investment, and nonprofit community to develop and implement strategies to grow local advanced transportation businesses and jobs.

REGIONAL INNOVATION IN ADVANCED TRANSPORTATION

Los Angeles and Orange Counties have strong innovation assets that are increasingly active in advanced transportation technologies. The region is home to top-tier academic institutions such as University of California Los Angeles, University of California Irvine, University of Southern California, and California Institute of Technology. These regional universities produce cutting-edge research and development, train a talented workforce, and support private industry in the development and commercialization of new technologies.

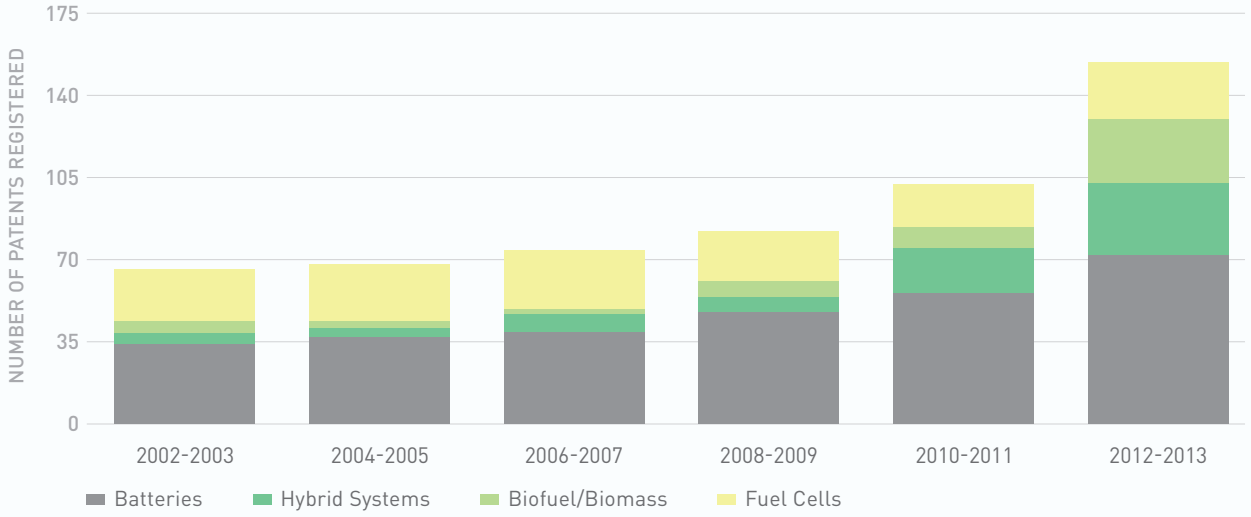
The region's existing industries, such as automotive design and aerospace, are also contributing to advanced transportation innovation. These industries are helping create and attract a well-trained technical workforce and regional expertise and supply chain in advanced technologies. Los Angeles is the nation's automotive design capital, with over 20 design centers in the region for renowned auto companies including Tesla, BMW, and Honda. These facilities support the creation and testing of new auto technology designs.

Companies and universities are ramping up research efforts in advanced transportation, as evidenced by the growing number of patents registered in the region (Figure 3). Regional inventors registered 154 advanced transportation patents in the 2012-2013 time period, more than twice the amount in the 2002-2003 period. Compared to the most recent 2010-11 period, hybrid patents in 2012-13 increased 63 percent, battery patents jumped 29 percent, fuel cell patents rose 33 percent, and biofuel/biomass patents tripled. Battery patents remain the largest category in the region, and hybrid patents, which includes technologies for new engines and integration with electric vehicles, place second. The region is a state leader in hybrid patents, with a total of 31, or 46 percent of the state total, from 2012 to 2013. Quallion is a developer of advanced lithium power solutions and has been the most active regional company in patent registrations in recent years, primarily in batteries (Table 1). General Motors ranked a close second with hybrid and fuel cell patents.

Intelligent transportation software is also a growing area in the region, with logistics software and services to support the ports, delivery systems, and the general public. Telogis, for example, is an Orange County-based company that ranked number one in innovation in a recent competitive assessment of the telematics industry by ABI Research. Telogis develops location intelligence software and network support for users. They are increasingly working with auto companies to integrate their software, and in 2014 announced partnerships with General Motors to integrate with the OnStar application, as well as Volvo Trucks to provide telematics and navigation services.[10]

The region is at the forefront of developing and testing hydrogen fuel cell and natural gas vehicle technologies, leveraging its local base of auto design centers and university research centers. Orange County-based Quantum Technologies develops CNG storage systems for vehicles, and was recently awarded a California Energy Commission grant to develop and test natural gas fuel systems with bus, medium-duty, and port truck applications.[11] In 2013, Honda debuted its fuel cell-electric vehicle

Figure 3: Advanced Transportation Patents, Los Angeles and Orange Counties



SOURCE: 1790 Analytics, Patents by Technology; USPTO Patent File
ANALYSIS: Collaborative Economics

Los Angeles' Emerging Waste-to-Energy Industry

Companies in the region are increasingly investigating new waste-to-energy technologies to generate electricity and renewable natural gas for vehicles. Waste-derived fuel offers greenhouse gas reduction benefits and an alternative end-use for waste, which is increasingly important with diminishing local landfill space. Los Angeles County houses 33 waste-to-energy facilities, utilizing a variety of technologies, ranging from anaerobic digestion to microturbines, and sources which range from landfills to waste-water treatment plants. Utilities including Southern California Gas Company and waste companies such as Waste Management are working closely with local stakeholders to remove barriers and increase innovation in waste–to-energy.

concept at the Los Angeles International Auto Show, with Hyundai following suit in 2014. Hyundai launched the first delivery of a mass-produced fuel cell-vehicle for the U.S. market at a port near Los Angeles in May 2014. These new hydrogen vehicles are pushing the envelope with their driving range expected to be longer than electric vehicles, reaching close to 300 miles, and shorter charging times of about ten minutes.[12]

In addition to vehicle technologies, hydrogen fuel companies like FirstElement Fuel are also establishing their roots in the area to tap into the local market and further accelerate fuel cell vehicle adoption. Innovation hubs like the National Fuel Cell Research Center at University of California Irvine are also accelerating technology development. The Center recently launched a demonstration site at the Orange County Sanitation District of the world's first high temperature Tri-Generation system, which uses biogas fuel from wastewater treatment that produces electricity, heat, and hydrogen fuel for fuel cell vehicles.[13]

Table 1: Top Inventor Companies in Advanced Transportation, Los Angeles and Orange Counties, 2010-2013

Company Name	Number of Patents 2010-2013	Most Active Patent Categories
Quallion	25	Batteries
General Motors	24	Hybrid/Fuel Cells
University of Southern California	13	Biofuel/Biomass
Broadcom Corp	8	Batteries
California Institute of Technology	8	Fuel Cells, Batteries
Cool Planet Biofuels	8	Biofuel/Biomass
Boston Scientific	7	Batteries
General Electric	6	Fuel Cells
Tesla Motors	5	Batteries, Hybrid Systems
Belkin International	5	Batteries
Toyota	4	Batteries
HRL Laboratories	4	Batteries, Fuel Cells
Nyko Technologies	4	Batteries
Quantumsphere	4	Fuel Cells
Honda	4	Hybrid Systems
Front Edge Technology	4	Batteries
Aerovironment	4	Batteries

SOURCE: 1790 Analytics, Patents by Technology; USPTO Patent File
ANALYSIS: Collaborative Economics

LACI has supported over 30 portfolio companies, which have raised $50 million and created over 400 jobs.

Regional Collaborations Supporting Innovation

Los Angeles and Orange Counties have a growing network of support for entrepreneurs and research activities around clean technologies, including advanced transportation. Cleantech OC, for example, is an Orange County-based trade association that is also playing a growing role in connecting companies, academic institutions, and government entities, as well as educating stakeholders on technologies and policies. Los Angeles Cleantech Incubator (LACI) and Port Tech Los Angeles are local incubators and commercialization programs that accelerate start-up development. Incubators offer business development support, mentoring, and access to a network of business and technology experts and investors. LACI has supported over 30 portfolio companies, which have raised $50 million and created over 400 jobs.

Los Angeles recently launched the construction of La Kretz Innovation Campus, which will be the 65,000 square foot future home of LACI, and also include clean technology demonstration centers, research and development labs, conference facilities, work force training facilities, and space for established clean technology companies. The region is stepping up efforts to lead advanced transportation innovation, illustrated by the 2014 announcement of the Southern California Center for Alternative Fuels and Advanced Vehicle Technology. This Center is funded by the California Energy Commission and includes a consortium of Southern California-based organizations led by the LAEDC. The Center will serve Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara and Ventura Counties, and work to align regional efforts to maximize economic development and growth while addressing energy concerns.

> Private and public stakeholders are collaborating with innovation centers in the region, such as universities and the LA Cleantech Incubator, to create a supportive network for entrepreneurs and start-ups to grow the advanced transportation and clean technology markets.
>
> **– Mike Swords,** LA Cleantech Incubator

CONCLUSION

Los Angeles and Orange Counties are successfully leveraging their vast consumer base and established industries to support the growth of a clean regional economy. The region's poor air quality has been an impetus to increase deployment of clean transportation technologies to the general public and business community. The region now has the largest share of electric and natural gas vehicles in the state, and the local transit agencies and Ports of Los Angeles and Long Beach are increasingly testing and using vehicles with lower or no emissions. The region is also developing new technologies to serve the local and global market, with an increasing number of advanced transportation patents and companies in the sector. The growing advanced transportation sector is continuing to create jobs in the region, while reducing air pollution and contributing to the state's environmental goals.

Endnotes

1. Analysis by Collaborative Economics, data source is the National Establishment Time Series Database- Green Establishment Database. Advanced transportation employment includes energy storage and clean transportation segments.
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LOS ANGELES AND ORANGE COUNTY ADVANCED TRANSPORTATION INNOVATORS NOTED IN THIS REPORT