California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Southern California E4 Advanced Transportation Center

Prepared for: California Energy Commission

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-13-605 to provide funding for projects that develop new centers or expand existing centers for alternative fuels and advanced technology in California. In response to PON-13-605, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards on October 1, 2013 and the agreement was executed as ARV-13-031 on June 5, 2014.

ABSTRACT

The Los Angeles Economic Development Corporation inaugurated the E4 Mobility Alliance, a professional group of executives from industry, government, and academia in 2010. It specifically focused on four key areas, thus the branding of "E4:" economy, energy, efficiency, and environment. The E4 Mobility Alliance dedicated it efforts toward growing the electrification, infrastructure, renewable methane, and hydrogen fuel cell transportation industry sector. In 2014, the E4 Mobility Alliance and Los Angeles Economic Development Corporation organized the E4 Advanced Transportation Center as a public/private partnership with CEC funding and with multiple match funding organizations.

The Center, in its almost 3 years of existence, has organized physical locations in Los Angeles (Los Angeles Cleantech Incubator), Orange County (Sustain Orange County in University of California, Irvine's Cove innovation center), and San Diego (Center for Sustainable Energy). Los Angeles Economic Development Corporation provides overall project and grant management including web site coordination for the multiple physical sites. In addition, the Los Angeles Economic Development Corporation provided digital marketing, maintained a mailing list, and organized quarterly meetings as well as executive advisory councils and transportation related webinars. Membership (opt in to mailing list) is now in the thousands and through regular E4 Mobility Alliance meetings, the Center has built a reputation for getting things done, connecting people, and convening regional leadership to address contemporary issues such as autonomous and connected vehicles.

Keywords: Los Angeles Economic Development Corporation, E4 Advanced Transportation Center, electric vehicle, plug-in hybrid vehicle, natural gas, fuel cell, alternative fuels.

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EXECUTIVE SUMMARY

The Southern California region covers a span of over 45,000 miles with over 22 million inhabitants. The close proximity between people and vehicles creates serious climate challenges related to clean air goals and clean technology demands. The California Energy Commission awarded a grant to the Los Angeles Economic Development Corporation to stand up a program to address the necessary clean air goals and new technology demands. This report summarizes the California Energy Commission grant project focusing on developing and improving alternative and renewable low-carbon fuels and zero-emission mobility.

To meet the goals of the California Energy Commission grant project, the Los Angeles Economic Development Corporation established the E4 Advanced Transportation Center. In the early stages, the E4 Advanced Transportation Center focused primarily on public awareness and adoption of electric vehicles. As adoption became more widespread and more models of electric vehicles appeared, the E4 Advanced Transportation Center shifted to focus on infrastructure demands and focus on overcoming the barriers to electric vehicle technology adoption. The E4 Advanced Transportation Center promoted and held numerous events including webinars, industry meetings, and demonstration such as ride and drives. Furthermore, the E4 Advanced Transportation Center convened regional stakeholders to respond to additional funding opportunities in an effort to grow the electric vehicle industry. The E4 Advanced Transportation Center promoted attraction efforts directed at engaging and securing international electric vehicle firms relocating to Los Angeles.

At the same time, the E4 Advanced Transportation Center advocated for fleet adoption in a range of alternative fuels including natural gas, fuel cell, and electric and plug-in hybrid vehicles. The E4 Advanced Transportation Center and its partners assisted with the Clean Cities initiative by writing transitional plans and options for fleet managers. Through coordinated events, fleet managers were able to take advantage of incentives, matchmaking meetings, and pilot programs that moved their businesses toward fleet conversion.

As part of this grant program, the E4 Advanced Transportation Center collaborated with local utility firms to define charger rebate programs and assisted utility firms in the adaptation of suitable Time of Use rate plans to encourage change to electric power in mobility sector. In sum, the E4 Advanced Transportation Center engaged with both public and private entities by nurturing an industry cluster and connecting opportunities with technology. With physical offices in Los Angeles, San Diego, and Orange County, the E4 Advanced Transportation Center participated in outreach and events with its partners to advance advanced and alternative fuel technologies.

Chapter 1: Center Operations

1.1 Goals for Grant

The goals of the E4 Advanced Transportation Center grant project were to create and launch two physical Centers and one virtual Center. The Centers were to have dedicated staff and personnel and leverage the expertise of formal and informal partners to facilitate regional coordination of alternative fuel and advanced vehicle technology. The Centers were tasked in providing a central location for companies, researchers, and public agencies to collaborate on alternative fuels, technology development, intellectual property protection, prototyping and technological needs.

The goals as listed above and in grant agreement ARV-13-031 were accomplished through the following organizations:

Advanced Transportation Center

The Los Angeles Economic Development Corporation founded the Advanced Transportation Center of Southern California as a resource to foster growth of the transportation industry. Its focus includes alternate fuels, innovative new changes in modes of transportation such as autonomous vehicles and more. The Advanced Transportation Center of Southern California was established to promote these technologies and assist this industry cluster as it grows successfully, which will lead to well-paying, skilled jobs, and add economic strength to the region.

E4 Mobility Alliance

The E4 Mobility Alliance's mission is to promote and further develop Southern California as the leader in advanced transportation including research and development and commercialization of autonomous vehicles, maximizing plug-in electric, natural gas and fuel cell vehicle adoption rates; fleet conversion; ride sharing and a range of e-mobility solutions that will enhance a robust manufacturing cluster and infrastructure deployment resulting in job growth and investment through appropriate levels of public and private funding; technology transfer; workforce development; and policy initiatives. Through this work, job creation is fostered, creating economic opportunity for our region's residents.

1.2 E4 Advanced Transportation Center Physical Sites

The E4 Advanced Transportation Center established physical sites at already existing business center as follows:

Los Angeles Cleantech Incubator

As a strategic player in the interface between public and private entities, the incubator has been a key location. Located just east of downtown, Los Angeles Cleantech Incubator is housed in the La Kretz center which receives lots of traffic, not just from the public for events such as student information and the Los Angeles Department of Water and Power showcase for new energy technology, but for foreign dignitaries and trade missions.

a. Focus Areas: Entrepreneurship, EV (Electric Vehicle) Showcase, Air Quality Impacts

b. Capabilities: Convening Space, Mentorship/Incubation, Demonstration Projects, Technology Transfer, Events

The meeting rooms and teaching classrooms offer a central location for events and meetings as well as a showcase for new energy technologies at Los Angeles Department of Water and Power. These new technologies include model energy efficient homes, microgrid solar, and a "living lab" of EV charging and supporting infrastructure.

Highlights of E4 Advanced Transportation Center at Los Angeles Cleantech Incubator activities include:

a. Established Downtown Los Angles Shared Mobility Pilot District at La Kretz Innovation Campus, up to five demonstration EVs presented by different manufacturers on site;
b. Transportation Cluster meetings; Women in Cleantech Group;
c. Mobility Center kiosk; Weekly docent-led campus tours;
d. Close working relationships with Advanced Transportation Center advisory council members, match fund partners, public agencies and elected officials;
e. EV charging microgrid at the La Kretz Center - GLOShow events annually with focus on electrification of transportation, participated with booth and speakers and panel.

Center for Sustainable Energy

Located in the heart of San Diego's technology sector, the Center for Sustainable Energy has long been a preferred organization for clean energy in San Diego. From San Diego Gas and Electric outreach to clean cities stewardship to EV rebate administration, the physical center has leveraged its skill sets and reputation as a clearinghouse for information and an aggregator of policies, grants and other public support for Advanced Transportation.

a. Focus Areas: Fleets, Rebates/incentives, Infrastructure, Grid Integration, Education and Outreach
b. Capabilities: Convening Space, Mentorship/Incubation, Demonstration Projects, Technology Transfer, Events

With a large 100-person meeting room, video broadcast capabilities for remote participation in events, and ongoing communication with local players (for example Clean Cities and their fleet electrification agenda) the center gives us a presence as a trusted local partner for information dissemination as well as roll out for new technologies.

Highlights for E4 Advanced Transportation Center at Center for Sustainable Energy include:

a. ISO 15118 International Testing symposium: More than 70 individuals from around the world testing different vehicles and charging;
b. Supporting Clean Cities events, additional distribution of United States Department of Energy Clean Cities program materials;
c. Hosting more than a dozen stakeholder meetings for the San Diego Regional Alternative Fuel Planning project;
d. Hosts monthly Electric Auto Association meeting;
e. Participation in California Airports Clean Vehicle Working Group monthly calls and expo.

Sustain Orange County

Sustain Orange County is the Orange County physical E4 Advanced Transportation Center site, located in "the Cove," an innovation center at the University of California at Irvine. As such, it hosts both venture capitalists and local cleantech startups as well as providing a path for commercialization of university research.

Sustain Orange County has held annual events around e-Mobility, with the E4 Advanced Transportation Center providing modest sponsorship and speakers, that has now become the premier e-Mobility event in Orange County. Sustain Orange County has also held quarterly workshops of related themes, support outreach for Orange County with a business focus. The facility has a meeting room suitable for 80+ attendees, with full audio-visual support on multiple screens.

Virtual Center

The E4 Advanced Transportation Center developed the layout and framework of the virtual Center website for the purpose of providing information about alternative fuels and advanced vehicle technologies in Southern California.

The E4 Advanced Transportation Center subcontracted with University of California, Los Angeles Smart Grid Energy Research Center to develop and publish a user manual for the online virtual training center website. See Appendix B.

1.3 Academic Partners

Working with E4 Advanced Transportation Centers, University of California, Los Angeles and California State University, Los Angeles have been active partners. They represent both outreach efforts on campus as well as research and actions contributing to cluster development. While E4 Advanced Transportation Center did not fund such research, the academic partners, shown in Figure 1, helped identify problems, convened grant teams, and disseminated the information useful for the growth of the E4 Advanced Transportation Center and its mission.

Figure 1: Centers, Partners and Core Competencies

Entity	Core Competencies
LAEDC	Project Lead; coalition building; foreign direct investment matchmaking; workforce development; industry partnerships; marketing and branding
LACI	Outreach; access; commercialization; incubation; events
CSE	CVRP administration; public/private partnerships; infrastructure development; surveys/reporting; outreach; workforce development
IEEP	Inland Empire outreach, business/coalition building and Logistics Council
UCLA-SMERC	Thought leadership; research; software development; demand response
CSULA	Advanced fuel technology, hydrogen fueling infrastructure and other clean technologies
UCLA Luskin Center	Case Studies, White Papers, data analysis
Cleantech OC	Workforce development; coalition building in business, government and academia, transportation related software development

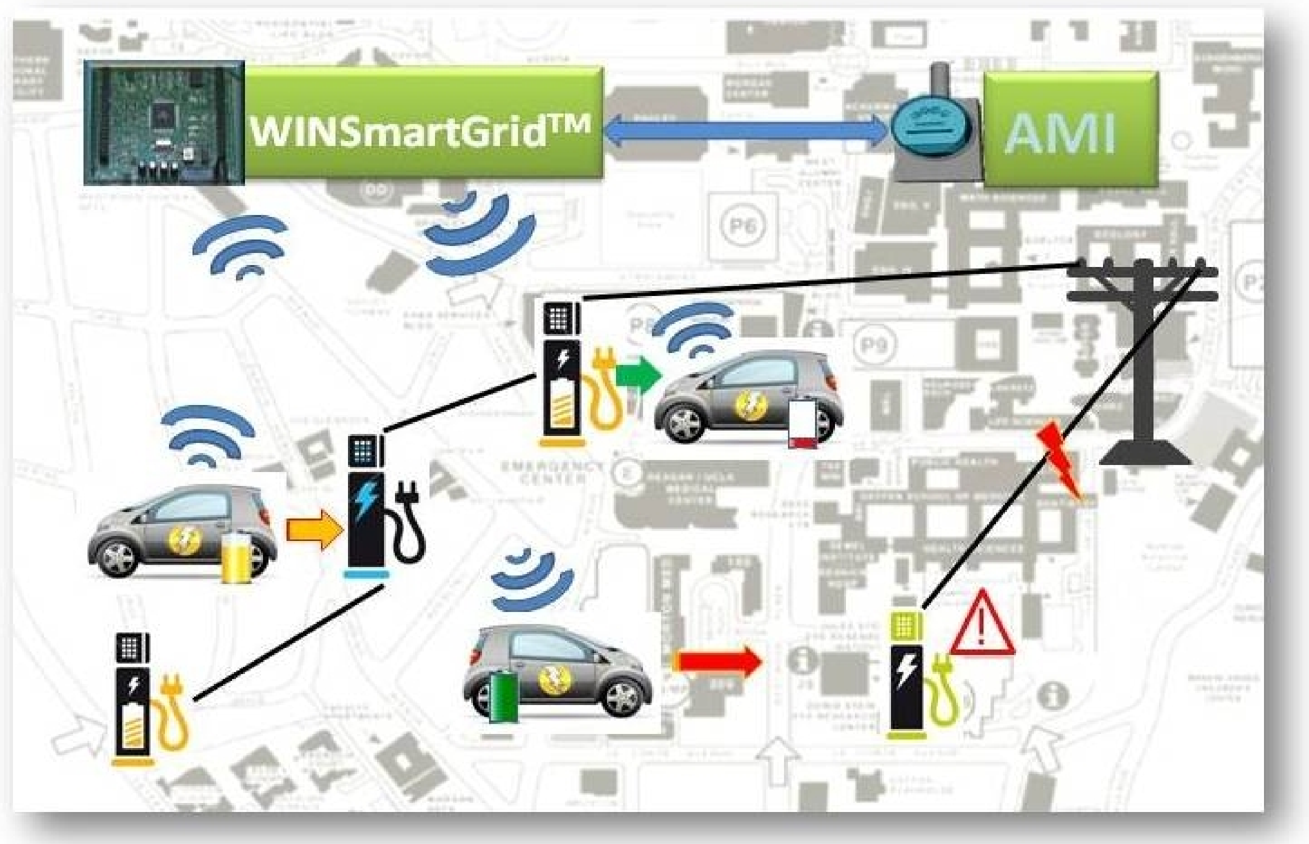
Source: Los Angeles Economic Development Corporation

University of California, Los Angeles's Smartgrid Energy Research Center developed a visualization tool useful for understanding and modeling EV charging load, as well as hosting events for the Advanced Transportation Center and cleantech community. E4 Advanced Transportation Center sponsored booths at four environmental and energy events on campus, and helped to commercialize some of Smart Grid Energy Research Center's technology in spin out MOEV, Inc.

Design of EV charging

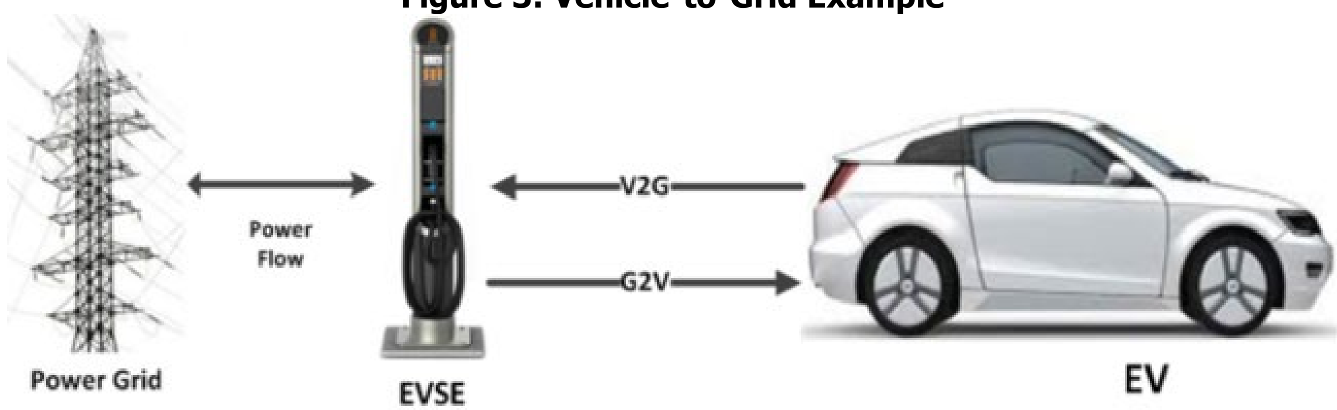
The visualization tool, developed technology, and events at Smart Grid Energy Research Center have leveraged its United States Department of Energy funded living lab with hundreds of EV chargers all over campus. This smart charging solution is shown in Figure 2.

Figure 2: WINSmartGrid



Source: Los Angeles Economic Development Corporation

Figure 3: Vehicle-to-Grid Example



Source: Los Angeles Economic Development Corporation

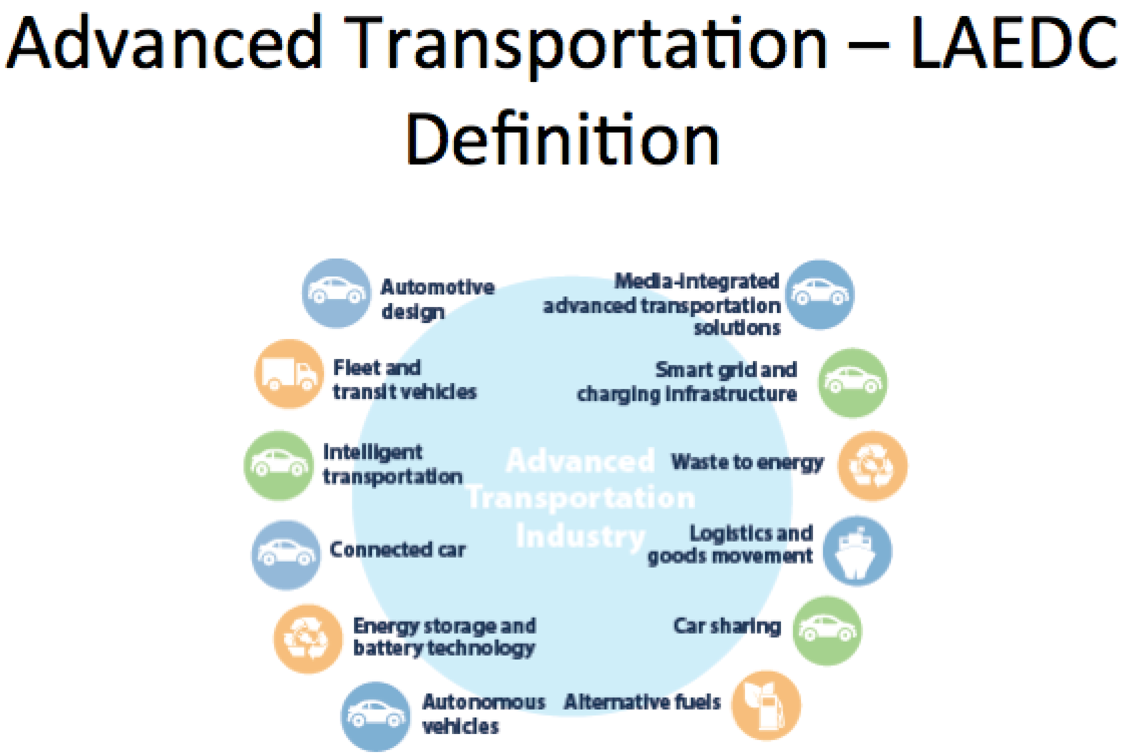
California State University, Los Angeles prepared a report for the E4 Advanced Transportation Center that included: a summary of the Cal State hydrogen research and fueling facility; an overview of the Cal State EcoCar team, details of its community outreach activities to underrepresented groups, and a summary of its autonomous and electric vehicle research. See Appendix A.

Chapter 2:
Branding And Marketing

2.1 Brand Development

The E4 Advanced Transportation Center built its branding efforts by first identifying the advanced transportation definition and sector, shown in Figure 4.

Figure 4: Advanced Transportation Definition



Source: Los Angeles Economic Development Corporation

Figure 5: E4 Advanced Transportation Center logo

Source: Los Angeles Economic Development Corporation

Figure 6: E4 Advanced Transportation Center Newsletter and Booth Display

Source: Los Angeles Economic Development Corporation

Figure 7: E4 Advanced Transportation Center Website

e4Mobility Alliance

Related Information

- Initiatives
- iDEA Hub
- Global Clean Port Summit
- Advanced Transportation @ Lunch Webinar Series
- e4Mobility Alliance

Latest News

- Autonomous Vehicles Event Varden Labs, Cal State LA, EcoCAR 3
- Innovation Thought Leadership Forum: Advancing the Electric Grid for the 21st Century Energy Needs
- Register Now for PortTechExpo 2016
- Women In Transportation: Working Together, Caltrans, Metro, LADOT event Feb 23
- Next LAEDC Economic Forecast to Focus on Advanced Transportation

The LAEDC's e4 Mobility Alliance is a network of over 600 leaders in advanced transportation that are working to grow, attract and retain advanced transportation jobs and investment in Southern California–making us a leader in not just consumption of this technology but also in producing, designing, developing and delivering it as well.

e4 is chaired by Jeff Joyner, Shareholder, Greenberg Traurig; Rick Teebay, Fleet Specialist, LA County Office of Sustainability; and Michael Boehm, Executive Director of the Advanced Transportation Center.

The e4Mobility Alliance meets on semi-monthly on the first Thursday and second Thursday of the month from 10am-11:30am.

To find out more about this group, please go here.

Source: Los Angeles Economic Development Corporation

The E4 Advanced Transportation Center newsletter reflected the E4 Advanced Transportation Center services and activities, shown in Figure 8. Circulation reached about 1,100 to 3,000 stakeholders per issue.

Figure 8: E4 Advanced Transportation Center Newsletters

Source: Los Angeles Economic Development Corporation

Table 1: E4 Advanced Transportation Center Marketing Metrics

Advance Transportation Center Activities	Monthly (Average)	Annually
Walk-Ins	250	3,000
Meeting Attendees	200	2,400
Posts (Facebook, Twitter (incl. retweets, ATC and LAEDC websites)	33	396
Facility Tours	4	48
Webinars		6
Outreach	20	240
Message Log (incl. request for ATC information, meeting/event registration at ATC)	500	6,000

Source: Los Angeles Economic Development Corporation

2.2 Marketing and Events

1. Participated in 21 events with exhibit space for marketing of Advanced Transportation Center activities.
2. Sponsored and promoted more than 200 events including the Los Angeles Economic Development Corporation Economic Forecast and Feb 2016 focusing on future of transportation in Southern CA.
3. Organized Advanced Transportation panels as part of event programs, i.e. Alt Car Expo, CleanTech Orange County Transportation Symposium, US-China Cleantech Innovation Forum (2 years), Los Angeles Economic Development Corporation Economic Forecast, Lunch and Learn webinars, Clean Tech Orange County Mobility conferences (3 years), etc.
4. Conferences, expos, tours, etc.: Clean Tech Orange County Mobility 3 (June 2016), Los Angeles AutoShow Advanced Transportation Networking event (November 2016), NEXTREND STEM + Robotics Expo in Logistics conference (March 2017)
5. Held first of its kind event west of the Rocky Mountains on Emergency Readiness by hosting 14th iREV/NASEO conference. Focus was on educating Southern CA emergency managers and public works departments on how alternative fuels fit into emergency planning.

2.3 Event Details and Examples

1. Webinars – advanced transportation topics co-hosted with other Advanced Transportation Centers include: CEC Planning Grant Webinar – 37 attendees; Cybercast event sharing San Diego Clean Cities fleet strategies; and iREV Workshop for Fleet and Emergency Managers
2. Manufacturing Day Lunch & Learn LA County – 28 attendees
3. CNG – Next Step to Clean Goods Movement Pathway
4. "Drive and Ride Week" - promoting electric vehicle adoption among consumers. The events included two University of California, Los Angeles drive and rides, Huntington Beach drive and ride, and three Glendale eCarfest booth and outreach. E4 Advanced Transportation Center estimates that these events reached tens of thousands of consumers.
5. LA Auto Show - booth at the LA Auto Show three years in a row. The event was well attended (100 attendees) and the attendees were exposed to local advanced technology companies, informed about state incentives, and recruited for E4 Advanced Transportation Center membership. In follow up, the LA Times published yearly articles about the E4 Advanced Transportation Center goals and activities at the auto show; this provided greater awareness for the E4 Advanced Transportation Center.
6. Coast to Coast Mobility - In cooperation with a Dutch initiative, E4 Advanced Transportation Center held three events presenting technology from the Netherlands and participated in outreach at the e-Grand Prix event in Long Beach. E4 Advanced Transportation Center assisted in recruiting EV Box from Holland to California. With E4 Advanced Transportation Center's leadership support, Peter Van Der Vender, a Dutch executive, established a fund for US e-mobility companies to open offices in the Netherlands. In additionally, we promoted academic projects in the US for the Netherlands.

7. LA Clean Cities - The Clean Cities initiative has been an important tool for impacting public fleets use of alternative and carbon-based fuel. The various cities involved in the program Clean Cities have been instrumental in adoption of fleet electrification and fleet change over to natural gas vehicles to reduce both carbon dioxide and particulate emissions. For fleet incentives and EV charging systems, Advanced Transportation Center has served as an advisor on topics, facilitator of speakers, and outreach for public programs including the medium-duty voucher program. In addition, the E4 Advanced Transportation Center has become a trusted advisor for these cities on electric infrastructure and fleet electrification. To that end, the E4 Advanced Transportation Center promoted the Northern California alternative energy product, Carbon Blue, a software product for fleet analysis identifying new vehicles and analyzing their return on investment in new Alt Fuel vehicles.
8. In addition, the Southern California Association of Governments and the e 4 Advanced Transportation Center collaborated to raise awareness for the need to bring partners together for regional planning for alternative fleets and vehicles for the Los Angeles area. The E4 Advanced Transportation Center involved Metrolink, Los Angeles Department of Transportation and other agencies bringing all parties to the table for an impactful discussion. From this collaborative effort, a technology council addressing coordination for the regional pilot policy was the outcome.
9. eBus Session - Matchmaking electric bus companies with purchasing agencies. Soon after Proterra, a leading e-bus manufacturer, opened a local manufacturing site. Several other e-bus companies including BYD, eBus, New Flyer and U.S. Hybrid opened local sites, resulting in an "industry cluster" emerging in the Southern California region, bringing not only manufacturing jobs to the region but cleaner fleets and the wide range of supply chain and engineering jobs with it.
10. Autonomous Vehicle - Established committees that delivered reports on technology, testbeds, regional needs, and local ordinance template for pilots. The E4 Advanced Transportation Center identified local resources, developed a regional plan, and implemented survey of other autonomous vehicle friendly regions. The E4 Advanced Transportation Center assisted Southern California Association of Governments, Metrolink, Los Angeles Department of Transportation convene key stakeholder to build a regional approach to Autonomous Vehicles. The E4 Advanced Transportation Center revisited the regional plan and updated goals and action items one year later. The E4 Advanced Transportation Center cooperated with local and national advocates to develop regional strategy. The E4 Advanced Transportation Center with assistance from member Urban Systems Lab developed a process for project identification, validation, and procurement of Autonomous pilots in the region. The E4 Advanced Transportation Center cooperated with Silicon Valley in establishing model for public private promotion of Autonomous Vehicle pilots and industry cluster. See “The Promise of Southern California for autonomous vehicles” PowerPoint in Appendix C.

Chapter 3: Organizational Development

3.1 Advisory Council

The E4 Advanced Transportation Center advisory council held monthly meetings to discuss funding opportunities, explore potential project and initiative partnerships, discuss trends, and innovations in the industry.

The E4 Advanced Transportation Center advisory council discussed regional expansion (added Orange County) as well as supplemental areas of focus: electric infrastructure, renewable natural gas, fuel cell, fleet upgrades including natural gas, and waste to energy. At a later stage, the advisory council added autonomous vehicles as an additional area of focus.

3.2 Advisory Council Partners

Los Angeles Department of Water and Power

The E4 Advanced Transportation Center actively engaged with Los Angeles Department of Water and Power, co-sponsoring and marketing at outreach events focused on EV adoption. We have also helped get the word out about Los Angeles Department of Water and Power Electric Vehicle Supply Equipment installation incentives with matchmaking between Los Angeles Department of Water and Power and the public, and sponsorships of events. Our lobby display at the physical center also helps promote EV adoption, including rebates and special Time of Use rates for EV charging.

City of Los Angeles

The E4 Advanced Transportation Center partnered with the City of Los Angeles to kick off an innovative car sharing program in Westlake and worked closely with the Los Angeles Department of Transportation on a regional plan for Autonomous Vehicles. This included a report leading to a roadmap, as well as multiple convening sessions bringing key public and private entities to the table to identify processes for autonomous vehicle Pilots.

Los Angeles Metro

The E4 Advanced Transportation Center worked closely with Metrolink on both fleet electrification (introduction of eBuses into the fleet, as well as natural gas-powered vehicles) and concepts for deployment of Autonomous Vehicles for first and last mile.

Southern California Edison

The E4 Advanced Transportation Center helped promote the Southern California Edison Charge Ready program, offering free charging stations (1,500 in the pilot phase, 28,500 to follow) including infrastructure expense included for the region.

Port of Los Angeles, Long Beach

The E4 Advanced Transportation Center helped the port publicize its innovation program and identify the workforce needs for port electrification, including trucks for logistics.

Clean Edge Study

The E4 Advanced Transportation Center partnered with Clean Edge and commissioned a study for data collection on EV readiness. The E4 Advanced Transportation Center also worked with them to review criteria for the rankings and LA ended up as a leader in EV adoption, according to the study metrics.

Chapter 4: Data Collection and Analysis

4.1 Recommendations for Future Growth

Economic Development - Capacity building entrepreneurship and mentorship through workforce development

Thought Leadership - Conferences, workshops, webinars, white papers and case studies

Disadvantaged Communities - Support efforts to reach underserved and impacted areas

Technical Assistance - Concierge service for cities Infrastructure Incentives and programs

4.2 Identification of Regional Assets

Large market

Los Angeles is an automobile-oriented community, linking together disparate geographic areas with air quality, congestion, and infrastructure challenges. These regional issues are driving industry trends for limiting fossil fuels-based vehicles and growing the electric vehicle business. Southern California, representing over 20 million users, has a regional vehicle sales market similar in size to many European countries.

Venture Capital Presence

The E4 Advanced Transportation Center's objective for cluster growth align with Venture Capital opportunities. Alternative transportation business growth in the region attracts innovative startups which in turn, create good local jobs. The E4 Advanced Transportation Center and its partners at the Los Angeles Cleantech Incubator, Sustain Orange County and the University of California Irvine innovation hub, held several events oriented toward connecting startups with good potential funding opportunities.

New Vehicle Technology

California, due to its generous incentives and energy conscious population, tends to be among the earliest adopters for new vehicle technology. Between 40-50 percent of plug ins vehicles are located in California. The Advanced Transportation Center contributed to this adoption rate in Southern California with its sponsorship of numerous outreach events including eCarfest, Alt Car Expo, Clean Tech Orange County Mobility Conference, just to name a few.

Urban Settings/Environments

Southern California is a large region with 7 municipal utilities and two Investor Owned Utilities. In addition, with its wide physical domain, there are various types of urban environments, making it an ideal launch ground for innovative mobility solutions for EVs including ridesharing and alternative fuel targets. The mix of workplace charging, fleet electrification, long commutes and urban density match roll out goals for innovative technology.

Ideal logistics

Commercial enterprise involving logistics, whether a dependency or a logistics service, is ideally sited in the Los Angeles area. The ports of Los Angeles and Long Beach, two of the busiest ports in the United States, offer easy international logistics, and technology in this domain, such as EV and plug-in hybrid electric vehicle drayage (category 8 trucks).

Solid Workforce

California is ideally suited for talent attraction that supports advanced mobility solutions. The region has many key stakeholders driving talent needs including the regions large and robust aerospace and defense industry. Their industry demands a skilled workforce in the areas of engineering and manufacturing/technician.

Experienced Management Pool

The decisive point in making Southern California a ready environment for advanced mobility commercial startups and business expansion is the deep pool of management talent. Local defense contractors, such as Boeing, Lockheed Martin, Northrup Grumman, and Aerovironment, have developed a generation of seasoned executives with local contacts and domain expertise. These management talents, developed locally, are often tapped for key positions in startups and local offices for advanced mobility companies, for example the EVGO charging network is located in Santa Monica and leverages Aerovironment alumni as management.

Supportive Agencies, Utilities, and Ports

The E4 Advanced Transportation Center has been instrumental at connecting local agencies, departments and entities to commercial opportunities with local companies. Los Angeles Department of Water and Power, Southern California Edison and San Diego Gas and Electric have all been involved in its initiatives around electrification, and Southern California Association of Governments, Metrolink and Los Angeles Department of Transportation have partners in developing a regional plan for autonomous vehicles roll out.

Chapter 5: Conclusion

Effective in Mission

While impact is difficult to measure, especially in cluster development, the E4 Advanced Transportation Center was instrumental in increasing the commercial footprint in Southern California in the advanced transportation sector. The E4 Advanced Transportation Center can identify several EV charging companies, including EVGO, Aerovironment, EV Connect, MOEV, BTC and others that participated in our events and expanded business operations or started up in the period of the grant. The E4 Advanced Transportation Center also saw great increase in electric bus manufacturing, leading to an industry leadership position, and now migrating to medium duty trucks leveraging the same technology and chassis.

Limited Scope

The E4 Advanced Transportation Center could have been more effective if it had been able to leverage funds to organize events, develop roadmaps, and assist in designing innovation demonstrations for the regions. As is, the E4 Advanced Transportation Center helped support, shape and influence the actors who conducted these activities. The E4 Advanced Transportation Center reacted well to the changes in issues in the region and helped bring the cleantech community to a focus on advanced transportation, accelerating the emerging industry cluster. The E4 Advanced Transportation Center partner, Los Angeles Cleantech Incubator, was especially instrumental in helping startups enter the space.

Overhead of Grant Writing and Administration

The E4 Advanced Transportation Center was challenged in complying with CEC grant administration processes, exacerbated by changes in project managers. This may have more salient if the E4 Advanced Transportation Center brought on more cost share partners and had to coordinate and train them in CEC mandated reporting and billing processes. These efforts occupied too much time in the early stages of the project and streamlining this process would allow for focus on the specific objectives of the grant. In addition, as the E4 Advanced Transportation Center looked for additional funding and had regular partner meetings to identify additional resources for the center's continued funding, this occupied valuable resources and attention that could have been best applied elsewhere - to regional issues and the core mission of increasing advanced transportation adoption and cluster development.

Statewide Collaboration

The E4 Advanced Transportation Center identified areas of collaboration with other Advanced Transportation Center awardees, and developed common promotion, social media and event dissemination (for example broadcast events and webinars). This was a very efficient way of promoting agendas in areas where statewide goals were aligned (for example fleet electrification). Some other issues were primarily regional (e.g. goods movement) and less appropriate for statewide dissemination. In review, more coordination for grant applications, coordinated agenda, and information sharing would have been good. The E4 Advanced Transportation Center collaborated on some grant applications (for example a mobile "ride and drive" kit) that jointly developed a rotation schedule for regional outreach across the state

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

ELECTRIC VEHICLE (EV)—A broad category that includes all vehicles that are fully powered by electricity or an electric motor

Appendix A:
California State University, Los Angeles Report for Spring 2017

California State University, Los Angeles is one of the leading academic institutions in California that actively develops clean vehicle technology and alternative fuel deployment. Its major projects in that area included in this report are (1) the Hydrogen Research and Fueling facility (2) the international EcoCAR3 competition; (3) nineteen electrical vehicle charging stations throughout campus, enabling faculty, staff and students to charge their clean vehicles while working and studying. These projects highlight the university commitment to the campus as a sustainable living laboratory environment that tests pathways toward renewable energy and carbon neutrality.

As an academic institution, California State University, Los Angeles integrates these project into corresponding curriculum preparing the workforce fluent in these technologies. Designated as a minority serving institution, the university is also active in community outreach and demonstrating technologies to students and public in the area. As a member of the Southern California E4 Advanced Transportation Center, California State University, Los Angeles has taken an advantage of programs, collaborations and support extended by the center to strengthen these projects. The university will continue with these projects expanding its vision into autonomous vehicle technology, hydrogen vehicle deployment and car sharing.

California State University, Los Angeles Hydrogen Research and Fueling Facility

The Cal State L.A. Hydrogen Research and Fueling Facility was formally opened on May 7, 2014, shown in Figure 9. As the largest university campus located hydrogen fueling installation in the nation, facility is actively engaged in research and demonstration projects, community outreach and available to Fuel Cell Electric Vehicles.

Using electrolysis the station is capable of producing hydrogen onsite from renewable energy sources. Fuel cell vehicles powered by hydrogen emit only water vapor!

Figure 9: California State University, Los Angeles Hydrogen Research Facility, November 2014, Fueling Hydrogen Audi

Source: Los Angeles Economic Development Corporation

The California State University, Los Angeles hydrogen station deploys the latest technologies with the capacity to produce and dispense 60 kilograms/day, sufficient to fuel 15-20 vehicles. The station utilizes a Hydrogenic electrolyzer, first and second stage compressors enabling 350 and 700 bar fueling and 60 kilograms of hydrogen storage, shown in Figure 10. The station is grid-tied with certified 100 percent renewable power.

In November 2014 the California State University, Los Angeles Hydrogen Research and Fueling Facility became the first in the world to sell hydrogen fuel by the kilogram directly to retail customers. This is a milestone in the commercialization of hydrogen in preparation for the next generation of electric vehicles that will be powered by hydrogen. Governor Jerry Brown's office informed the university that the fueling facility has received the certification known as the California Type Approval. This is the equivalent to getting the very first sticker from the state government to sell gasoline by the gallon.

Figure 10: Major Equipment Inside Hydrogen Station

Source: Los Angeles Economic Development Corporation

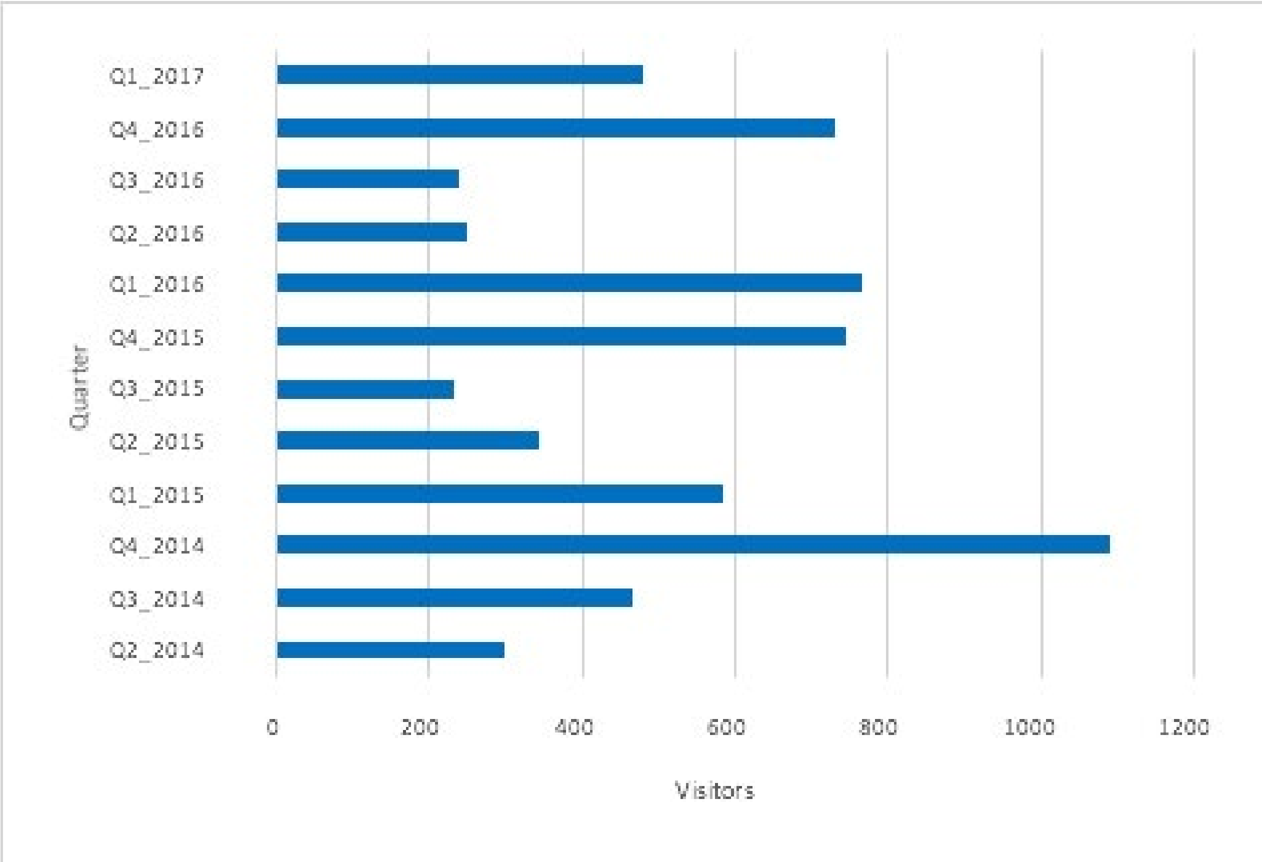
The campus has acquired three Hyundai fuel cell vehicles, shown in Figure 11, which are deployed in public safety and commuter roles. The campus is interested in expanding its hydrogen vehicle car sharing program.

Figure 11: California State University, Los Angeles Law Enforcement Hydrogen Vehicle (left) and a Commuter Vehicle (right)

Source: Los Angeles Economic Development Corporation

California State University, Los Angeles Hydrogen Research and Fueling facility staff is very proactive in public outreach and education about alternative fuels and clean transportation. More than 6000 visitors toured the station since its grand opening in 2014, shown in Figure 12. In the first quarter of 2017, California State University, Los Angeles Hydrogen and Fueling Facility hosted twelve tours and 481 visitor. The majority of visitors are students.

Figure 12: California State University, Los Angeles Visitors to the Hydrogen Research and Fueling Facility during 2014-2017



Source: Los Angeles Economic Development Corporation

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Figure 13: California State University, Los Angeles Hosts Student Visitors and Professional Meetings

Source: Los Angeles Economic Development Corporation

Additionally, California State University, Los Angeles has hosted a number of professional meetings, equipment testing, first responder training, filming of news and documentaries, international dignitaries, members of governments and diplomats, as shown in Figure 14. Several students have been interning at the station and some have secured jobs in the hydrogen infrastructure field.

Figure 14: California State University, Los Angeles Hosts International Visitors: Finnish Diplomats (January 2017), Counsel General of Netherlands in San Francisco (October 2016), and Members of Australian Parliament (2015),(left-to-right)

Source: Los Angeles Economic Development Corporation

California State University, Los Angeles EcoCAR team

EcoCAR 3 is a four-year advanced plug-in hybrid passenger vehicle design-and-build competition sponsored by United States Department of Energy and General Motors and managed by Argonne National Laboratory. Plug-in hybrid vehicles utilize advanced power plant architectures that combine internal combustion engines, electric motors and batteries that enable vehicles to drive on sustainable electricity and clean alternative fuels. California State University, Los Angeles is the only competitor from California among 16 North American universities chosen to participate, shown in Figure 15.

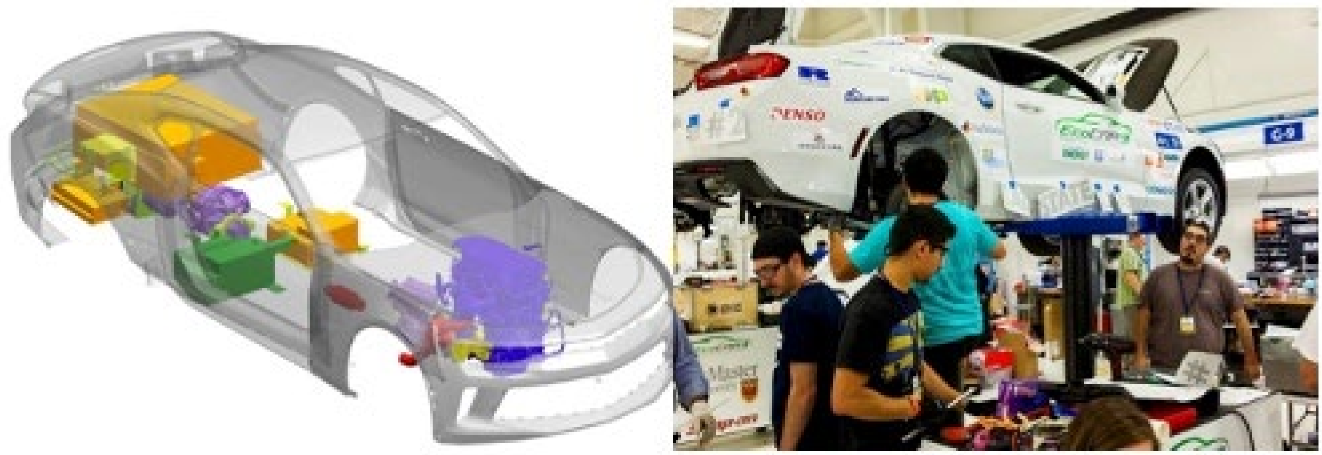
Figure 15: California State University, Los Angeles Team With its 2016 Hybrid Camaro

Source: Los Angeles Economic Development Corporation

California State University, Los Angeles team is designing a Parallel Post Transmission Plug-in Hybrid Electric Vehicle based on a 2016 V6 Chevrolet Camaro. Parallel architecture allows the engine and the electric motor to operate as the sole source of propulsion or in combination with each other.

Based on Los Angeles culture, the team is building a police fleet-oriented vehicle that takes into account the unique features of police needs and plug-in hybrid vehicle capabilities, shown in Figure 16.

Figure 16: California State University, Los Angeles EcoCAR Hybrid Vehicle Modifications to a Stock 2016 Camaro and Working on the car (right)



Source: Los Angeles Economic Development Corporation

This includes operating air conditioning and police electric gear while parked without running the engine. In addition, plug-in operation can assure significant electrical vehicle mode operation when patrolling. Operating in these modes reduces fuel consumption and associated emissions, while dual parallel power plant assures high performance. Fuel savings vs electricity costs would also result in financial savings to police departments.

Community Outreach Activities to Underrepresented Groups by California State University, Los Angeles EcoCAR Team

One of the activities EcoCAR 3 has developed over the years is the use of modules (solar car kit and build your own electric car) to inspire and motivate those within developing areas (low-income/inner-city), high in minority populations, to promote Scient Technology Engineering Mathematics education for those without access. The workshops also include discussions of advanced transportation, alternative fuels, and hands on activities. Figure 17 shows EcoCAR team organized workshop during the Engineering Open House event every October. Typically the team organizes two workshops for about 150 -200 students in two sessions. Multiple tables are set up and hosted by the team members. We explain electrical transportation and sun energy that can enable emissions free propulsion. Groups of students assemble solar car kits and race their cars. In addition, we open up our garage the same day to host several hundred more visiting students. The team uses its most ethnically diverse members to make the biggest impact by sharing their life experiences and inspiring students to strive for a college education.

Figure 17: Engineering Open House

Source: Los Angeles Economic Development Corporation

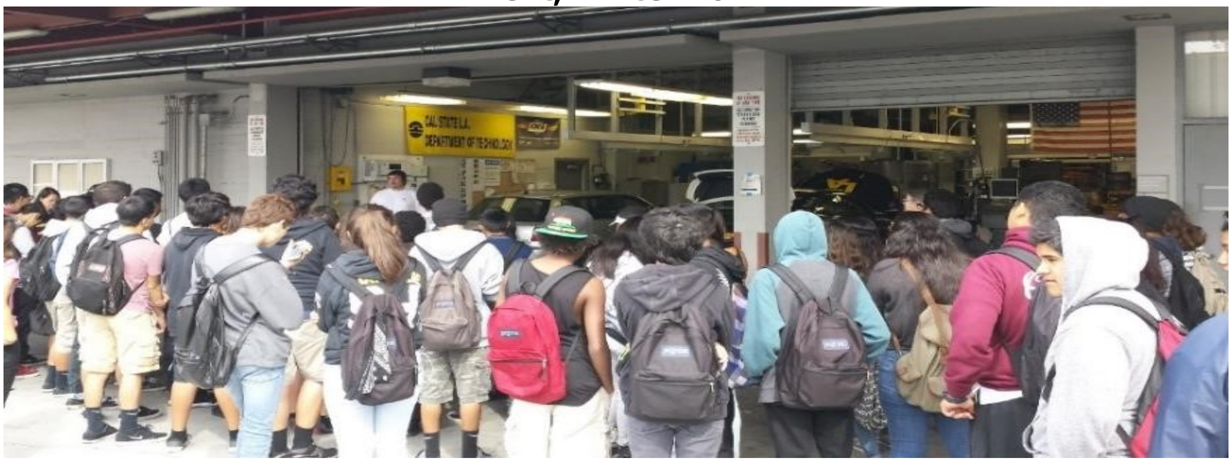
Our exemplary team members provide students located in lower socioeconomic communities hope that they too (with a little hard work and perseverance) can be an engineer. Additionally, the team often will use their native languages, such as Hindi, Spanish, and Mandarin to communicate lessons and workshops to community members who may not yet have fluent grasp of English. This additional effort by members gives participants a sense of belonging and understanding. Activities, such as workshops, brings volunteer team members closer together because they get to see first-hand how they've impacted the life of a minority youth.

The team consistently collaborates with local schools and organizations hosting EcoCAR garage tours for more than a thousand students every year. Multiple events are represented in the images shown in Figure 18 through Figure 21.

Figure 18: Engineering Open House

Source: Los Angeles Economic Development Corporation

Figure 19: MESA (Mathematics, Engineering, Science Achievement) Outreach Event, winter 2017

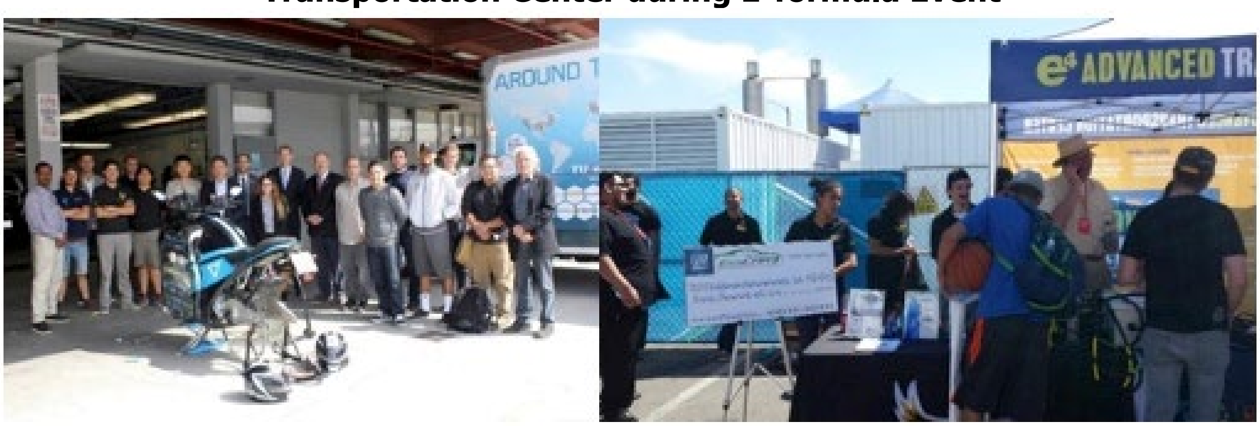


Source: Los Angeles Economic Development Corporation

Figure 20: A Local Engineering and Design Pathway Program from Schurr High School

Source: Los Angeles Economic Development Corporation

Figure 21: Storm, an Electric Bike Team from Eindhoven, Netherlands visits EcoCAR Team in October 2016 and an Outreach Event in Collaboration with the Advanced Transportation Center during E-formula Event

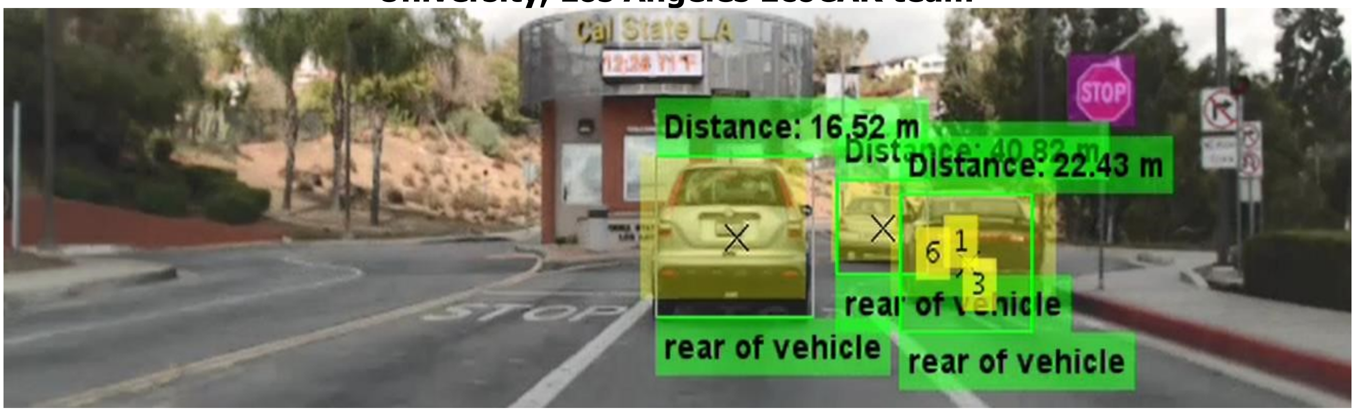


Source: Los Angeles Economic Development Corporation

Autonomous Vehicles by California State University, Los Angeles EcoCAR Team

One of the directions pursued by California State University, Los Angeles and its EcoCAR team is development and adoption of autonomous vehicles. In particular the team is working on developing stereo vision with cameras, shown in Figure 22.

Figure 22: Autonomous Vehicle Technology Development by California State University, Los Angeles EcoCAR team



Source: Los Angeles Economic Development Corporation

In addition to research, the autonomous vehicle knowledge has been shared by an EcoCAR member electrical engineering student Tom Pudpai. Tom presented his work to California State University, Los Angeles TECH 4700 Electric and Hybrid Vehicles course in November 2016, shown in Figure 23. In March 2017, he followed up with a presentation at E4 Mobility Alliance meeting at Los Angeles Cleantech Incubator. Providing the members with an overview of the technology and work done by the EcoCAR team.

Figure 23: California State University, Los Angeles EcoCAR team member Tom Pudpai Presents His Work In Autonomous Vehicles

Source: Los Angeles Economic Development Corporation

This is not the first engagement in that technology. In spring 2016, California State University, Los Angeles hosted the Varden Labs with their autonomous campus shuttle. That was followed by an invitation to display at Port Tech LA Incubator event shortly, thereafter, shown in Figure 24.

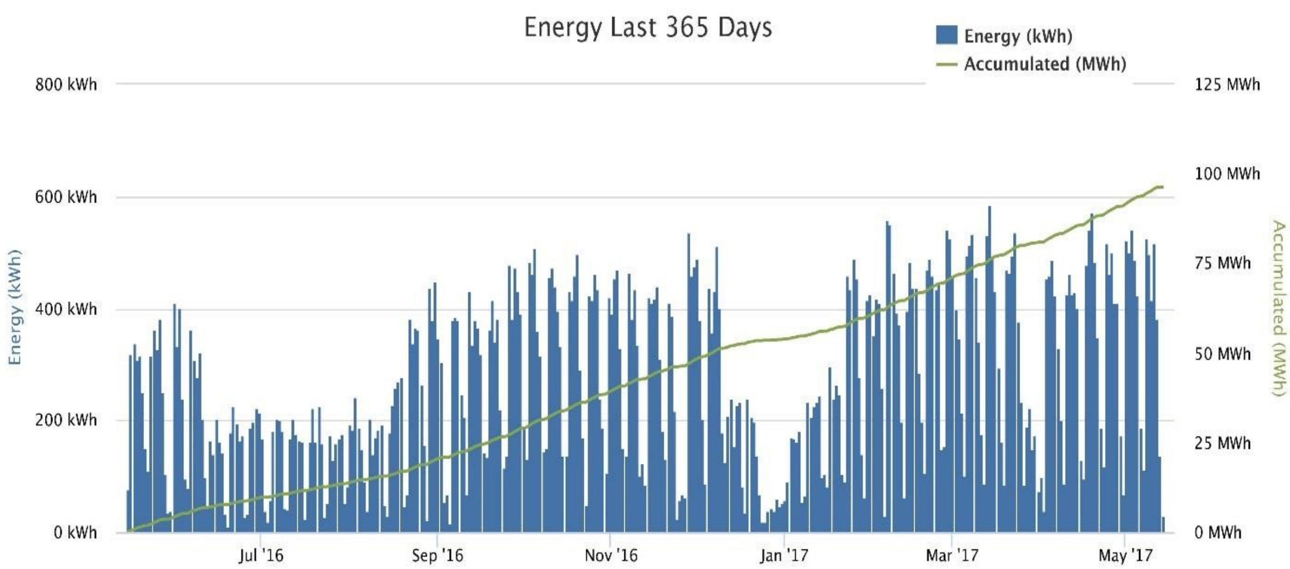
Figure 24: The Varden Labs Autonomous Shuttle Demonstration at California State University, Los Angeles campus and During the Port Tech Incubator conference, March 2016 (right)

Source: Los Angeles Economic Development Corporation

Electrical Vehicle Charging Infrastructure

California State University, Los Angeles is one of the pioneers in adopting electrical vehicle infrastructure following the initial installation of two Charge Point units in February 2011. Currently the university hosts 19 charging ports, where 11 were installed in Sept 2015 with Readiness EV. The last 4 ports were installed in November 2016, demonstrating California State University, Los Angeles commitment to providing its community with alternative fuel options. Over 34,000 charge ups and 30,000 gallons of gasoline has been saved since inception. Over the past year, 100 megawatt hours of free electricity has been dispensed, shown in Figure 25.

Figure 25: California State University, Los Angeles Electrical Vehicle Charging May 2016 Through May 2017, More Than 100 Megawatt Hours Provided On Campus



Source: Los Angeles Economic Development Corporation

Future Plans

Recognizing its leadership in hydrogen and electrical vehicle infrastructure, has lead California State University, Los Angeles to start identifying its current strength and opportunities to grow in developing these technologies and better serve the campus and neighboring communities. This is paving the way to developing a Campus Clean Transportation and Fleets Vision Plan, which components are being explored by an initiative group. Therefore our future plans outlined below represent some of the elements to be included in the vision plan as it takes a firmer shape.

California State University, Los Angeles is well poised to continue demonstrating the latest in hydrogen technologies. Having a reliably operating hydrogen station coupled with workforce development is an excellent launching pad for success in this proposition. Another motivation is coming from realizing that a mass production of traditional passenger fuel cell vehicles will be lacking for some foreseeable future. This leaves our station underutilized and hence capable of providing the campus with more hydrogen. On top of that, there also exists the need to update its fleets: forklifts, run-abouts, pick-ups, tug vehicle, lawn equipment etc. Currently only a price difference with a conventional unit is holding back the campus. Another, technology that has been developed by Plug Power and demonstrated for FedEx is a tug vehicle similar to the one in California State University, Los Angeles operation, shown in Figure 26. Run-abouts and pick-up vehicles can also be introduced into the hydrogen mix, shown in Figure 27.

Figure 26: Hydrogen Forklift by Nuvera and Yale is Tested at California State University, Los Angeles

Source: Los Angeles Economic Development Corporation

Figure 27: California State University, Los Angeles Vehicle Fleet

Source: Los Angeles Economic Development Corporation

Over the past several years, California State University, Los Angeles has grown from 24,000 students up to 30,000. This has overwhelmed the campus parking facilities requiring the Parking and Transportation services to secure off-site parking and provide shuttle service. Currently, 6-7 shuttle buses are deployed, and several can be substituted with a clean hydrogen option.

Among other initiatives California State University, Los Angeles is poised to grow its car sharing program and pursue research and curriculum development in the area of smart transportation infrastructures and autonomous vehicles.

Special Thanks

Being a part of the Southern California E4 Advanced Transportation Center has been a truly rewarding experience. Working for the center provided benefits of networking, partnerships for grant opportunities, attending conferences and meetings, support letters, and foremost professional growth by staying current with latest technologies and events.

True gratitude is expressed toward every member of the center and special thanks is extended to the following colleagues:

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JoAnne Golden-Stewart

Michael Boehm

Jeff Joyner

Lisa Mirisola

Tamara Perry

Misha Houser

Alicia Walker

Appendix B: Online Virtual Training Center

Microgrid Online Training Center Overview

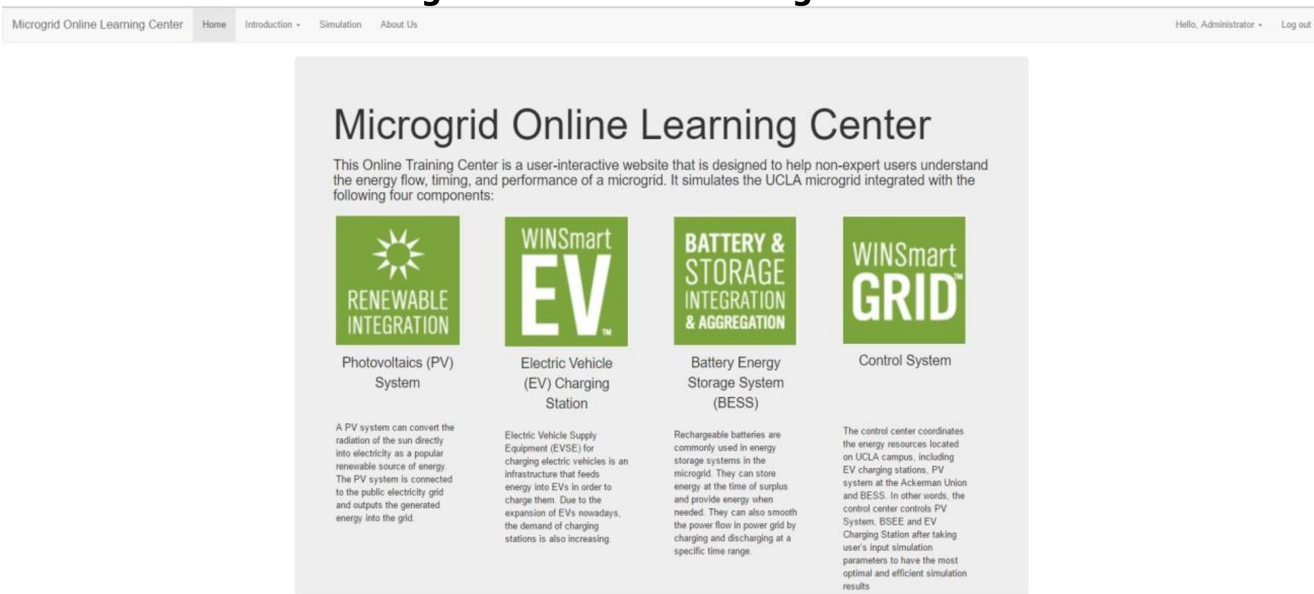
This Microgrid Online Training Center is a user-interactive website that is designed to help non-expert users to understand the energy flow, timing, and performance of a microgrid. It simulates the University of California, Los Angeles microgrid integrated with four different components: Photovoltaics system, Electric Vehicle Charging Station, Battery Energy Storage System, and Control System. The website consists of the following pages:

- User Authentication System
- Home
- Introduction page for different components:
  - Photovoltaic System
  - EV charging station
  - Battery Energy Storage System
  - Control System
- Simulation
- About us

The user authentication system makes the components of the website invulnerable, and also helps administrator protect the website from being accessible for none-target users. Not only it allows user to enter their account information privately, but also let them sign up with new accounts, as well as retrieve their passwords and/or usernames by email. The introduction pages give users with background information of each system and help them have a better understanding of the whole microgrid system integration. The simulation webpage allows users to adjust parameters of each component. Once parameters are entered, the back end of the Online Training Center will start simulating, and then, displaying simulation results through some user-interactive plots. Thus, the user can study the impacts of such components on the microgrid according to different simulation parameters. The overall goal for the Online Training Center is to let users have a fundamental understanding about microgrid through a user-interactive website by displaying visual simulation results. Figure 28. Online Training Center

Online Training Center Website shows the home page of the Microgrid Online Training Center website.
(Each user requires an independent account to log into Online Training Center.)

Figure 28: Online Training Center



Source: Los Angeles Economic Development Corporation

Online Training Center Website User Authentication System

The user authentication system includes a back-end database to store users' account information, a user account registration interface, a user log in interface, and a user password or username recovery page.

Database

A database is created to store and update users' account information. Table 2 shows the structure of the database.

Table 2: Database Structure

#	Information Stored	Variable Name	Variable Type (length)
1	User ID	user_id	Int(11)
2	Username	username	varchar(32)
3	Password	password	varchar(32)
4	First Name	first_name	varchar(32)
5	Last Name	last_name	varchar(32)
6	Email	email	varchar(1024)
7	Active	active	Int(11)

Source: Los Angeles Economic Development Corporation

Note that the password is encrypted by the md5 algorithm. The "active" sign aims to help administrator manage the website in such a way that certain users will be granted or refused to access to the major contents of the Microgrid Online Training Center.

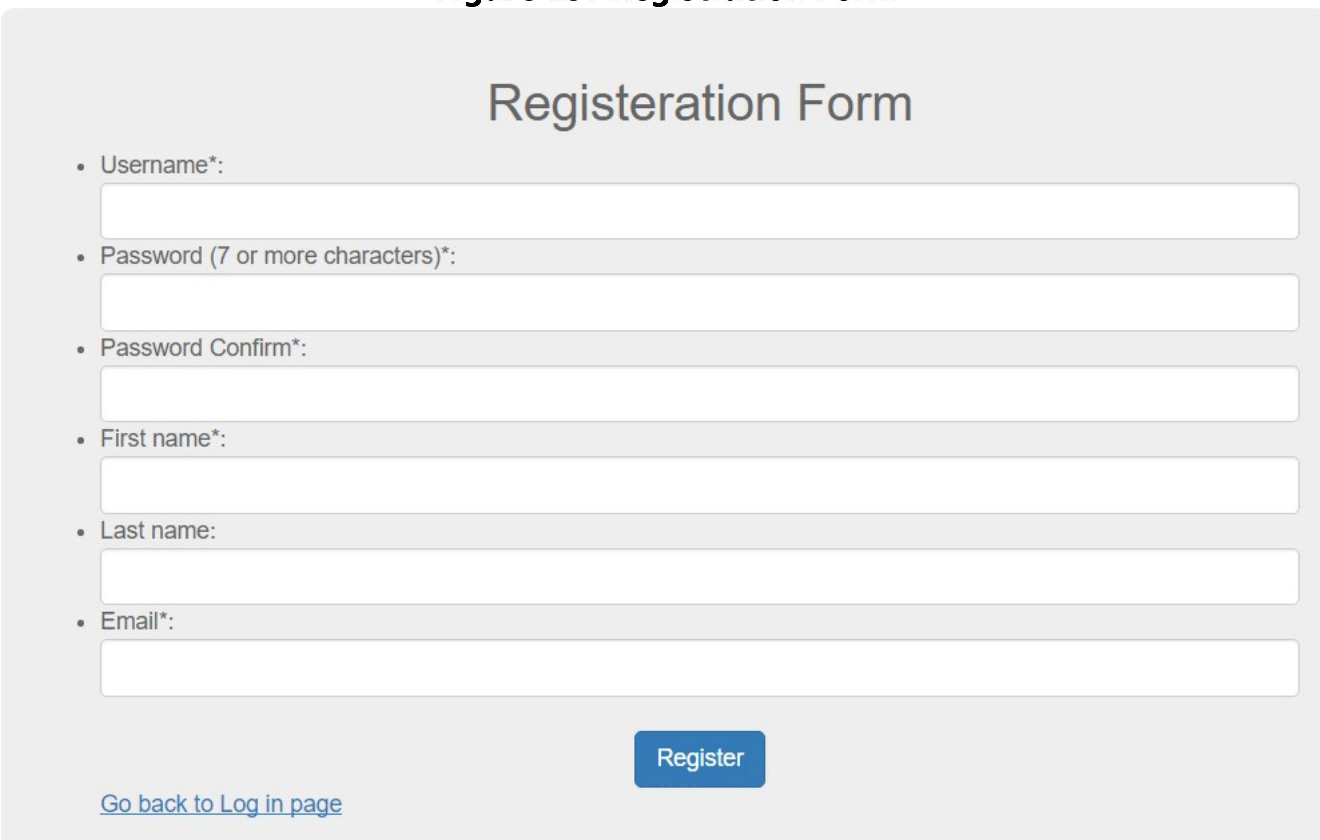
User Account Registration

The user account registration allows users being able to sign up new accounts so that they can log into the system afterwards. The registration form asks user to provide certain information to store in the back-end database.

Front-end Webpage Design

The user is required to fill out a registration form in order to sign up with new account. This form asks user to provide the following information and has specific requirement in each input field. Figure 29 shows the interface design of the user registration form.

Figure 29: Registration Form



Source: Los Angeles Economic Development Corporation

Table 3 lists the user input information and its requirement in detail.

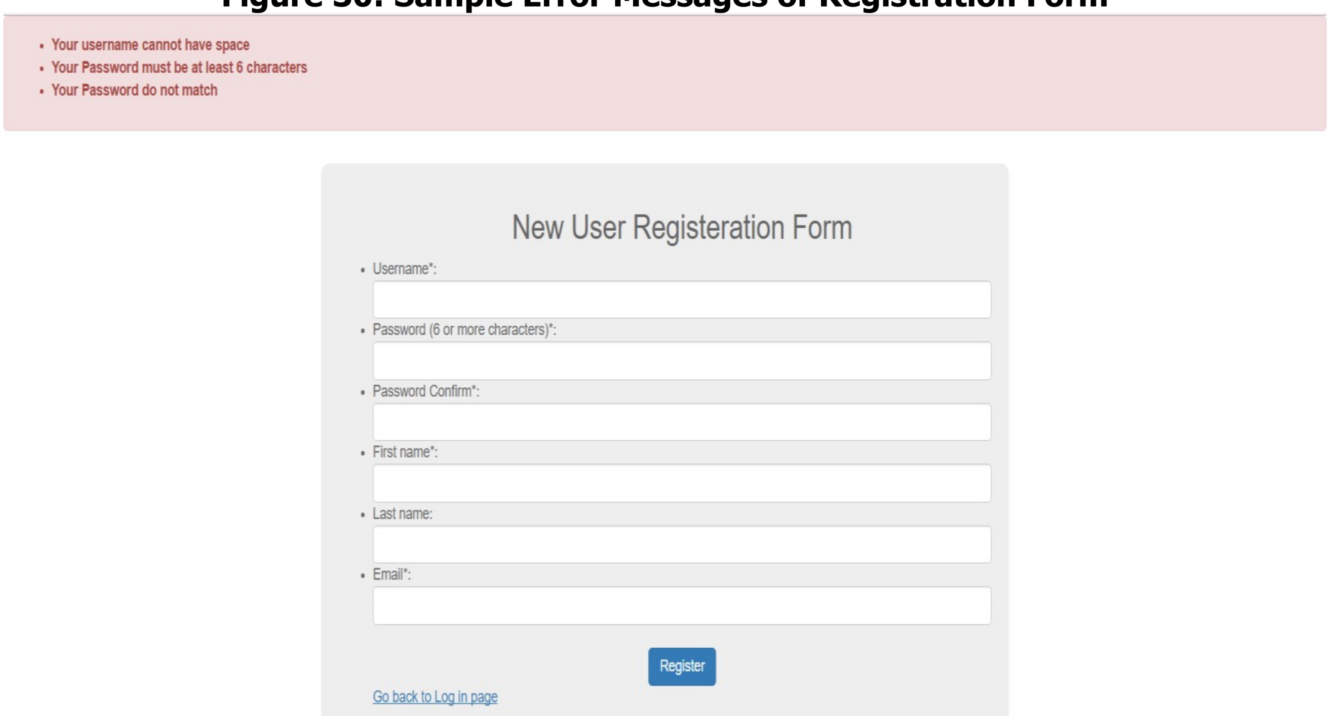
Table 3: Registration Form User Input

User Input Information	Requirements
Username	☐ Required ☐ Each username must be unique ☐ Username cannot have space
Password	☐ Required
	☐ Password must be at least 6 characters
Password Confirmation	☐ Required ☐ Must match with Password field
First Name	☐ Required
Last Name	☐ Optional
Email	☐ Required ☐ Must match with general email format ☐ Each email address must be unique

Source: Los Angeles Economic Development Corporation

The system will show an output error message if the requirements are not met shown in Figure 30.

Figure 30: Sample Error Messages of Registration Form



Source: Los Angeles Economic Development Corporation

If the user's input does not meet above requirements, the following corresponding error message will be outputted to the webpage:

1. Fields marked with a star are required
2. Please enter valid email address
3. The email address already exists
4. Your password must be at least 6 characters
5. Your password does not match

Back-End System Architecture

All the user input data in the registration form is stored in an array called register_data. Then, by using "post" method in php, the register_data array is sent into function register_user ($register_data). The function will store all the user registration values into database. This is done by the build-in php function mysql_query() and mysql insert query. In the end, new user account's registered information will be stored into the database. All the error messages are stored in an array and managed by nested if statements.

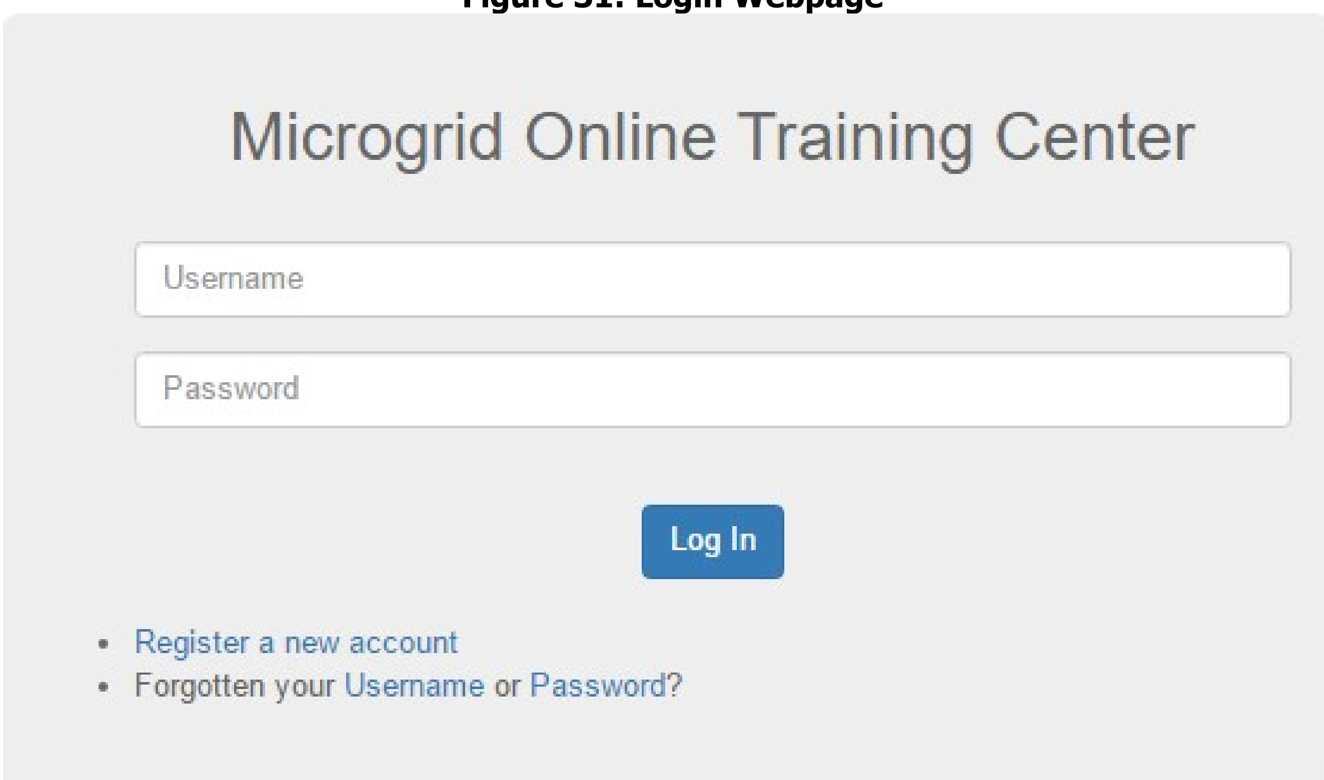
User Account Login

The user account login webpage checks users' information before granting them access to the microgrid online learning center.

Front-end Webpage Design

Figure 31 shows the login webpage interface design.

Figure 31: Login Webpage



Source: Los Angeles Economic Development Corporation

Users are able to enter their username and password in login webpage to have access to the microgrid learning center. They can also navigate to the registration webpage and user account recovery webpage by clicking the corresponding blue heighted texts. The pair of username and password must match with the corresponding record in the database, otherwise, relevant error messages will pop up to inform user. There are three different error messages:

1. Please enter your username/password.
2. The username entered does not exist. Please enter a new account.
3. Wrong pair of username/password.

Back-end System Architecture

The username and password that the users enter is posted into login($username, $password) function (The password is encrypted by md5 algorithm). This function will compare the pair of username and password in the database with stored pairs. If there is a match, the function returns true, and redirects the login page into the home page of microgrid online training. If there is no match, corresponding error messages will output to the login webpage and stop user access to the Microgrid Online Training Center.

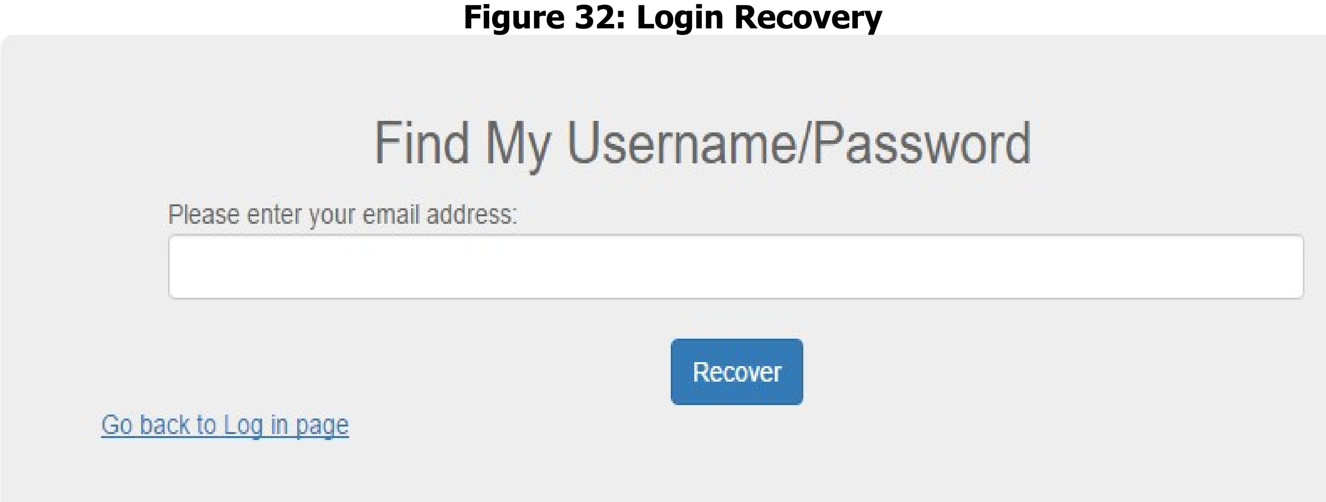
User Account Recovery

Users can retrieve their username or password in the recovery webpage by entering their registered email address.

Front-end Webpage Design

Users are able to enter their registered email address in the recovery page, shown in Figure 32, by clicking the blue heighted texts on the login webpage. If their information is matched with a record in database, an email will be sent to the user with corresponding username or system generated temporary password. If the system cannot find the email address user entered, it will output error message: "Sorry, we cannot find your email address."

Figure 32: Login Recovery



Source: Los Angeles Economic Development Corporation

Back-end system architecture

The email address entered by users is sent to the recover($mode, $email) function by php "post" method. This function will retrieve the username by matching the email address registered in database. It can also generate a random password encrypted by md5 algorithm if there is a match of the user entered email address in database. Consequently, the corresponding username or password information will be sent to the registered email address by a php build-in mail function.

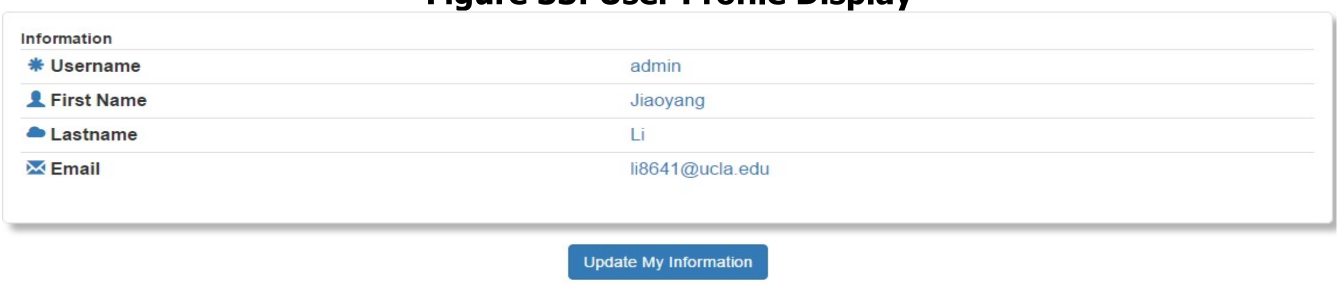
User Account Profile Display & update

Once the user accesses to the microgrid learning center, he/she can also view her profile information, update his/her information, and change her password.

Front-end Webpage Design

By selecting "My Profile" under the dropdown menu in the navigation bar, users will be able to see their own profile information: username, first name, last name and email address. This is shown in Figure 33.

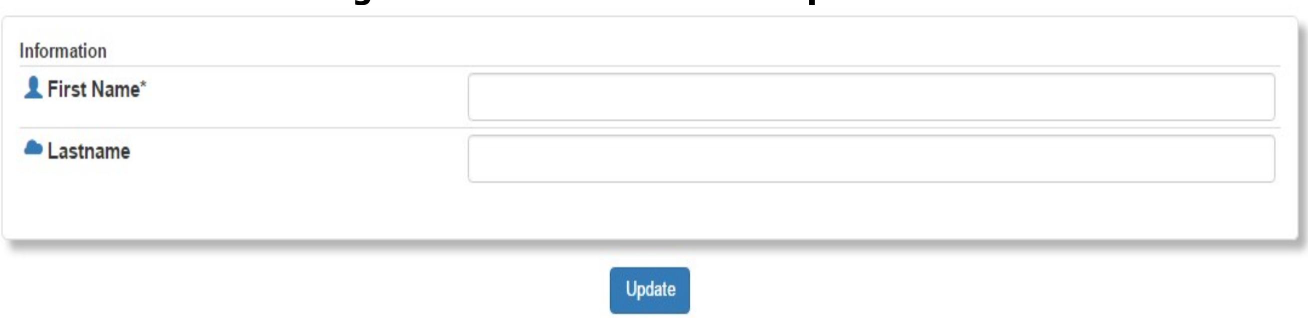
Figure 33: User Profile Display



Source: Los Angeles Economic Development Corporation

Users can also update their information (first name and last name) by clicking the "Update My Information" button. This is shown in Figure 34.

Figure 34: User Information Update Form



Source: Los Angeles Economic Development Corporation

Table 4 shows the requirement for each user input parameter:

Table 4: Update Form Requirements

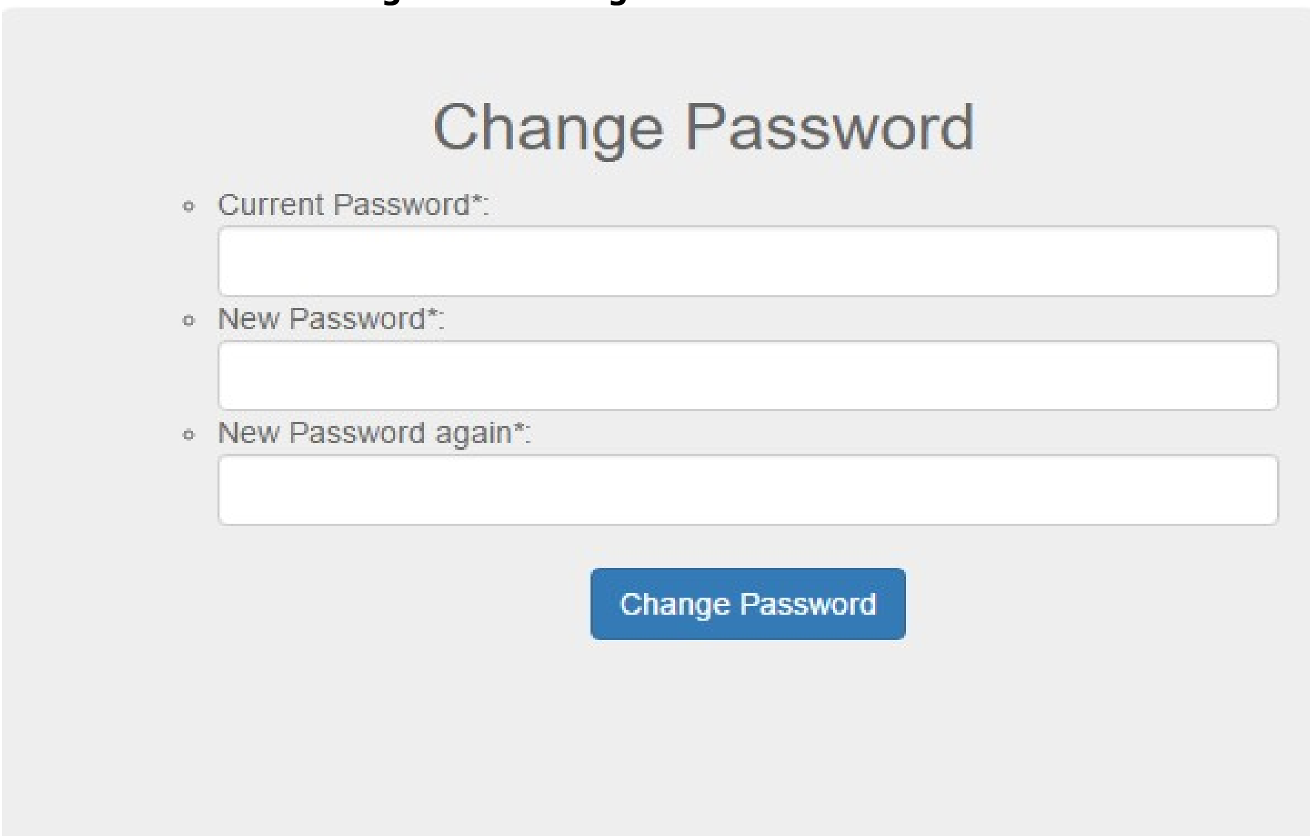
User Input Information	Requirements
First Name	☐ Required
Last Name	☐ Optional

Source: Los Angeles Economic Development Corporation

If the user's input does not meet above requirements, the following corresponding error message will be outputted to the webpage: "Fields marked with a star are required."

Users can also change their password by selecting the "change password" tab under the dropdown menu in navigation bar at the top of the webpage. Figure 35 shows the user interface design of the changing password page.

Figure 35: Change Password Interface



Source: Los Angeles Economic Development Corporation

Table 5 shows the user input requirements:

Table 5: Change Password Parameter Requirement

Current Password	☐ Required ☐ Must match with record in database
New Password	☐ Required ☐ Must be at least 6 characters
Confirm New Password	☐ Required ☐ Must match with the previous field

Source: Los Angeles Economic Development Corporation

If the user’s input does not meet above requirements, the following corresponding error message will be outputted to the webpage:

1. Fields marked with a star are required.
2. Your current password is incorrect.
3. Your new password does not match.

Back-end system architecture

For user profile display, function user_data($user_id) is used to retrieve the specific user’s information with the user id as input. This function is accomplished by a query from the user database.

For user information update and change password webpage, both of them use the post method from php to post user input into specific designed function. As for user information update, function update_user($update_data) is created to update the new user data into the database through an update query. The change password webpage, on the other hand, utilizes the

change_password($session_user_id, $_POST['password']) function to update the user password in database. Again, this function updates specific user’s password by an update query in user database.

Micro-grid System Architecture and Hardware Specification

The Online Training Center is an integration of the following components: Photovoltaics System, Electric Vehicle Charging Station, Battery Energy Storage System, and a Control Center.

University of California, Los Angeles Smart Grid Energy Research Center has over 3 years of data collection on the above-mentioned systems. Through simulation software contribution from industry partners such as OSI Soft, Applied Systems Engineering Inc. and National Instruments, the system produces simulated data set for current online training system.

Photovoltaics System

Photovoltaics System Background & Architecture

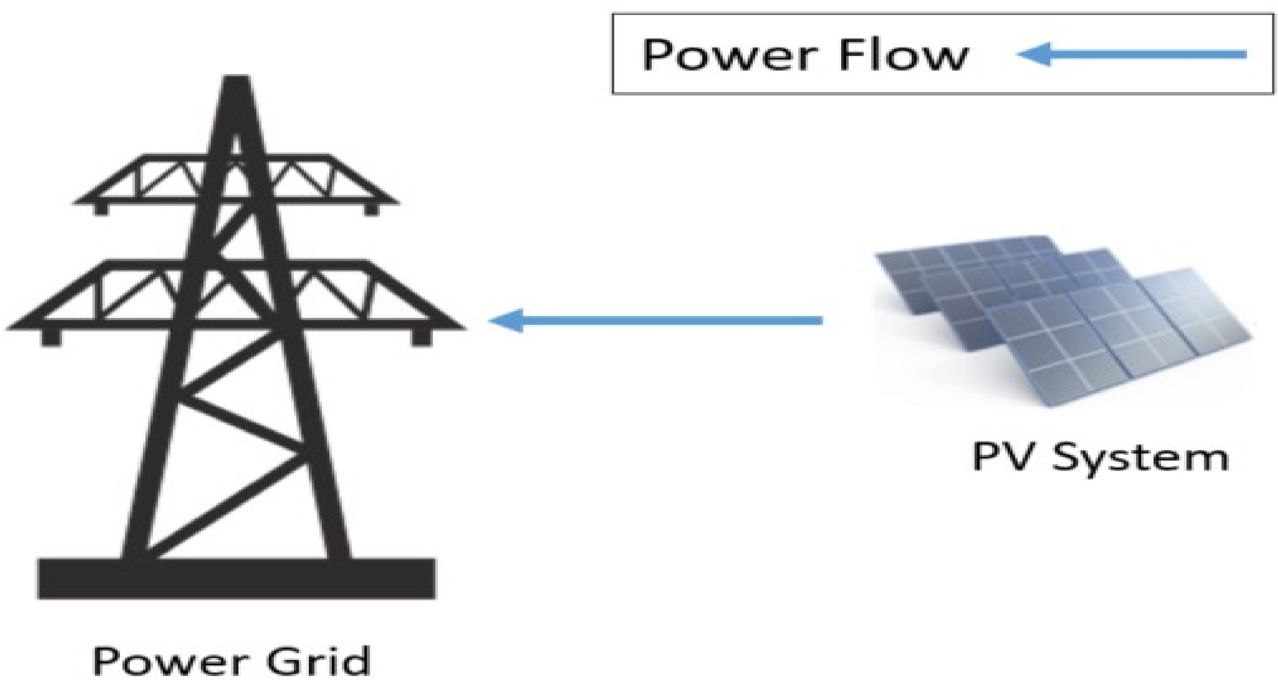
A Photovoltaic system can convert the radiation of the sun directly into electricity as a popular renewable source of energy. One of the biggest advantages of the Photovoltaic system is that it can generates electricity without any heat engine to interface. Therefore, Photovoltaic system could be used as a single and unique system to generate electricity range from microwatts to megawatts. The Photovoltaic system is connected to the public electricity grid and outputs the generated energy into the grid. The generated electricity is in Direct Current form and needs inverters to be inverted into Alternating Current form for residential or commercial usage. The Photovoltaic system is now mounted on the rooftop of Ackerman union at University of California, Los Angeles campus, and all the simulation data in Online Training Center is based on this particular Photovoltaic system. The Photovoltaic system output performance depends on the weather condition on each day. Therefore, there are three weather conditions in Online Training Center: sunny day, cloudy day, and rainy day. Figure 36 shows the Photovoltaic system at the University of California, Los Angeles Ackerman Union.

Figure 36: Photovoltaic System at University of California, Los Angeles Ackerman Union

Source: Los Angeles Economic Development Corporation

The generated electricity from Photovoltaic system will potentially feed into EV charging stations to meet the demand, and/or to the Battery Energy Storage System to charge the battery through the grid. Figure 37 shows the Photovoltaic System Configuration power flow relationship.

Figure 37: Photovoltaic System Configuration



Source: Los Angeles Economic Development Corporation

Hardware Specification

Photovoltaic system Nominal Power output:

- Max Capacity: 35 kW

Metering Device on Grid:

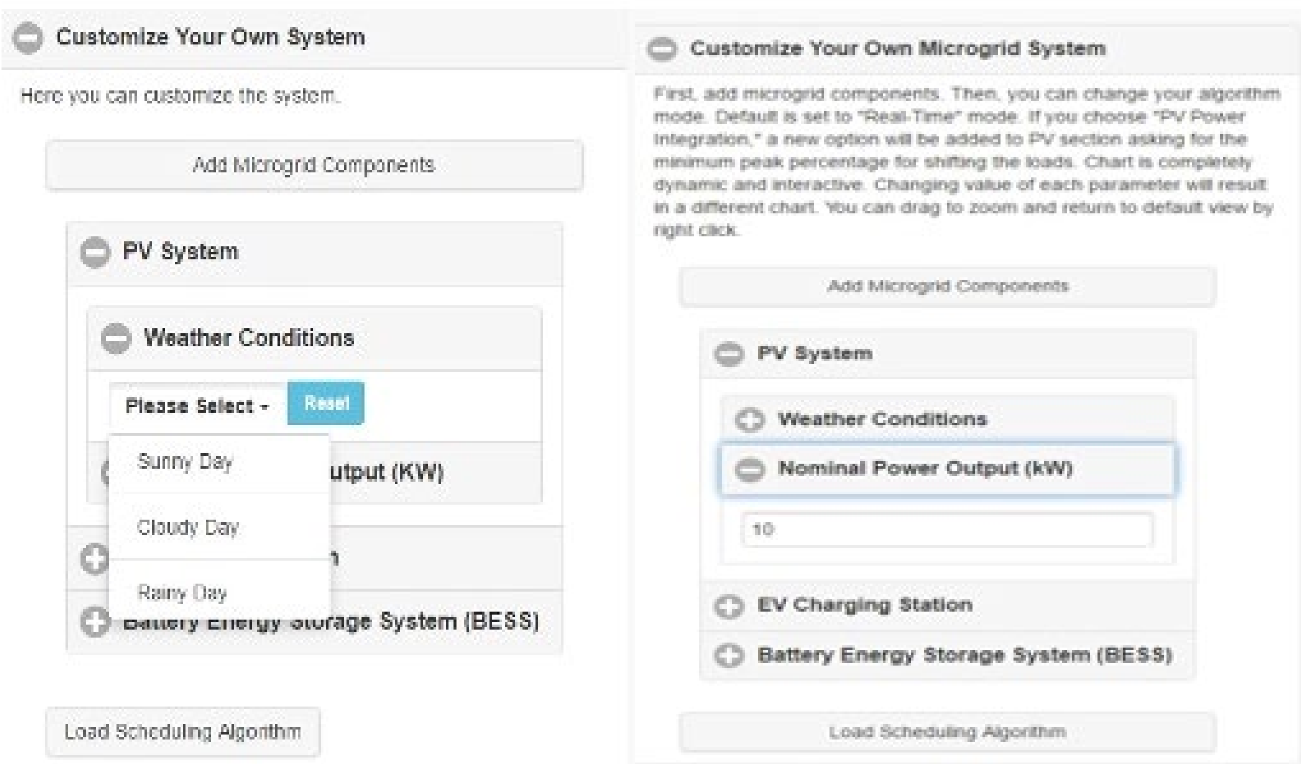
- Voltage
- Current
- Active Power
- Apparent Power
- Power Factor
- Frequency

Simulation webpage front-end & back-end design

Front-End Design

The Online Learning Center website asks user the following input parameters to enable the simulation, shown in Figure 38.

Figure 38: Photovoltaic System Simulation Interface



Source: Los Angeles Economic Development Corporation

Back-End Design

The Photovoltaic system data is extracted from the Photovoltaic panel's data collection at Ackerman Union at University of California, Los Angeles. The data has total of 96 points which simulates in 24 hours with 15-minute time resolution. The most representative data were chosen to be different weather conditions: sunny day, cloudy day, and rainy day. When the user chooses one of the weather conditions, a JavaScript function will query the relative column of data in the database to be plotted. The nominal max power output will be taken as magnitude scaling in the back-end system.

Electric Vehicle (EV) Charging Station

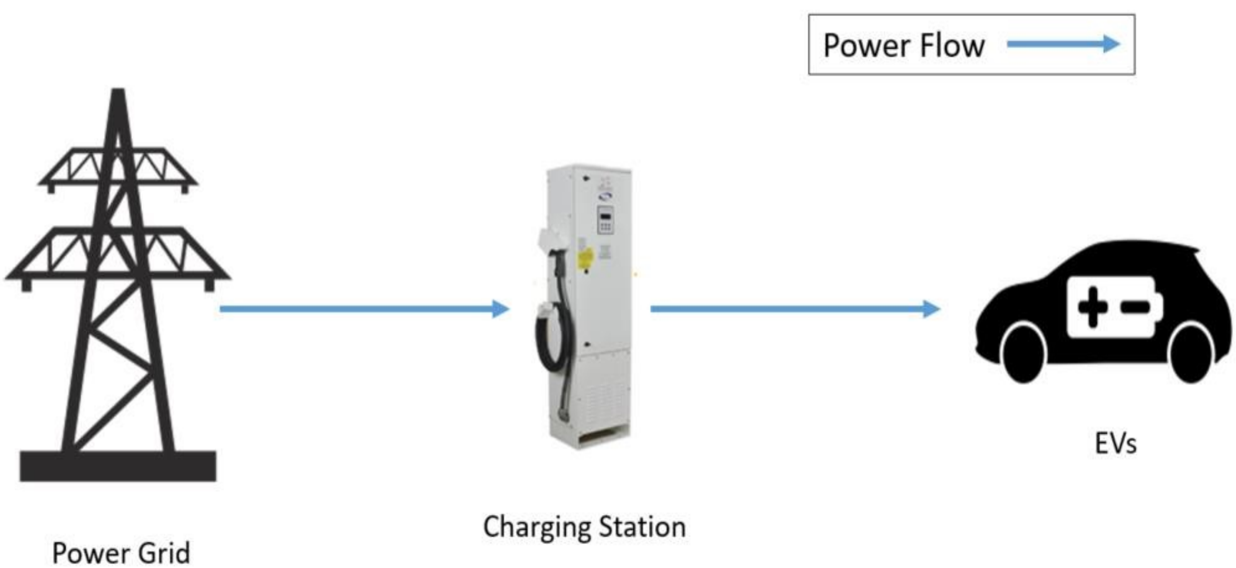
Background & System Architecture

Electric Vehicle Supply Equipment for charging electric vehicles is an infrastructure that feeds energy into EVs in order to charge them. Due to the expansion of EVs nowadays, the demand of charging stations is also increasing. On the other hand, the increasing number of EVs would also cause some problems and uncertainties in our grid. For example, if EVs are charging in totally random time duration, it will create new load peaks which is not efficient for grid to operate. Thus, we need to have an energy management system to create energy allocation to both satisfy the user's needs as well as grid operation. In this project, charging stations are divided into two groups based on their different environments:

1. Residential charging stations: Charging EVs overnight
    a. Workplace level
    b. Fleet yard
2. Public charging stations: Charging while parked
    a. Workplace

EV Charging Station System, shown in Figure 39, shows the power flows from the grid into charging station in order to charge EVs. It is a single direction power flow since the charging station can only retrieve power from the grid. (We do not consider power flow from charging station into grid in this project.)

Figure 39: EV Charging Station System



Source: Los Angeles Economic Development Corporation

Hardware Components

This section provides specifications for hardware components in the system, shown in Table 6.

Table 6: Charging Station Specification

Charging Environment	Charging Station Type	No. of Charging Stations
Fleet Yard	Level 1	20
Workplace	Level 2	16

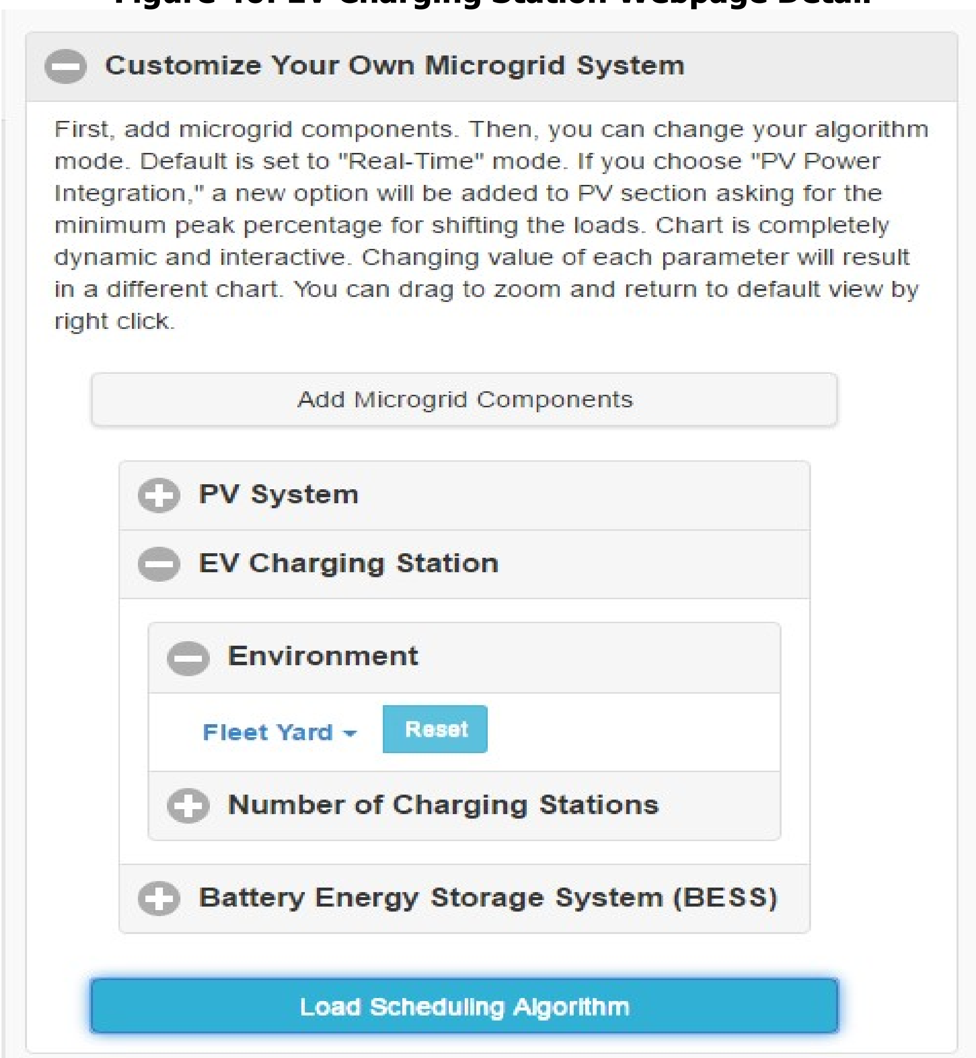
Source: Los Angeles Economic Development Corporation

Simulate Page Front-End & Back-End Design

Front-End Design

The user will input the following parameters shown in Figure 40 in order to simulate.

Figure 40: EV Charging Station Webpage Detail



Source: Los Angeles Economic Development Corporation

Back-End Design

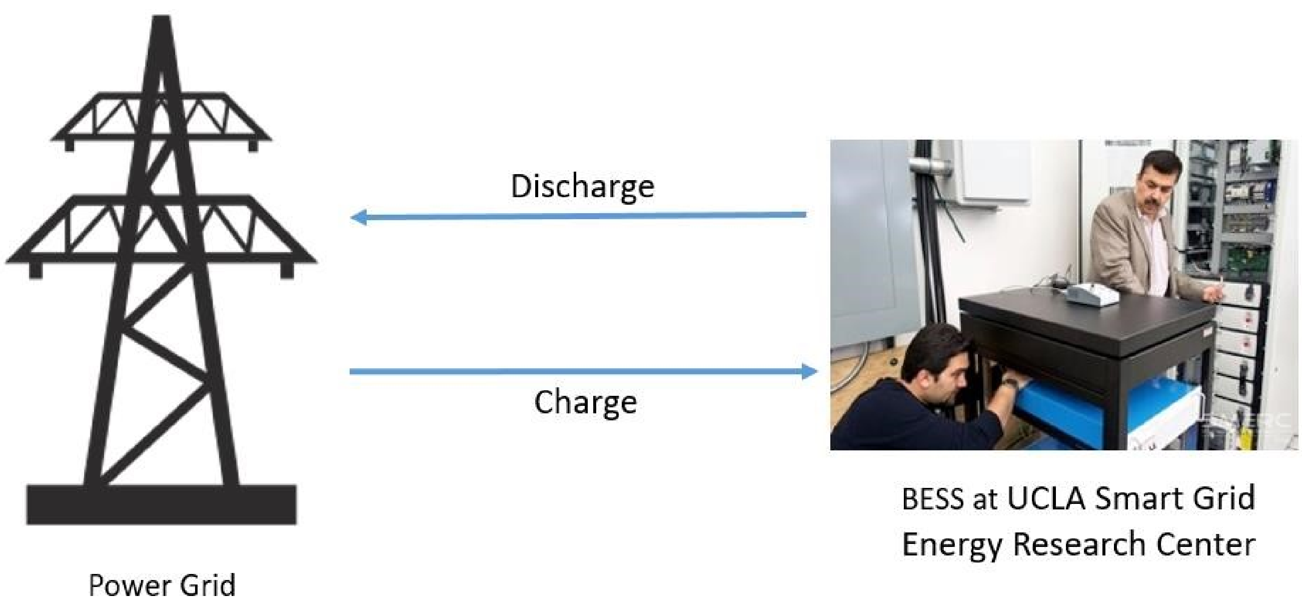
The data of Photovoltaic system is collected from University of California, Los Angeles Smart Grid Energy Research Center. Once the user has selected the charging station environment, the back-end system would query from database to give user the corresponding output based on his selection.

Battery Energy Storage System

Background & System Architecture

Rechargeable batteries are commonly used in energy storage systems in the microgrid. They can store energy at the time of surplus and provide energy when needed. They can also smooth the power flow in power grid by charging and discharging at a specific time range. The most commonly used batteries in Battery Energy Storage System are lead-acid battery and lithium battery. The lead-acid battery has a relatively low energy density and lower cost. On the contrary, lithium-ion battery has higher energy density and also a higher cost. Lithium-ion battery is deployed as Battery Energy Storage System in this project. The system configuration is shown in Figure 41.

Figure 41: Battery Energy Storage System Configuration



Source: Los Angeles Economic Development Corporation

The Battery Energy Storage System has lots of benefits in improving the performance and reliability of microgrid:

1. Peak shaving: by employing Battery Energy Storage System, the peak demand for EVs could be potentially drop since Battery Energy Storage System is supporting the demand.
2. Improve power reliability of the grid: Battery Energy Storage System can potentially provide electricity when there is a power outage in grid.

Mathematical Model

In this project, the Battery Energy Storage System charging and discharging rate is defined in the equation in Figure 42.

Figure 42: Battery Energy Storage System Charging Rate

$$Charging\ Rate = \frac{BC - BE(t)}{BCS}$$

$$Discharging\ rate = \frac{BE(t)}{BCS}$$

Note: BC = Battery Capacity, BE(t) = Current Battery Energy, BCS = Battery (Dis)Charging Speed
Source: Los Angeles Economic Development Corporation

Hardware Specification

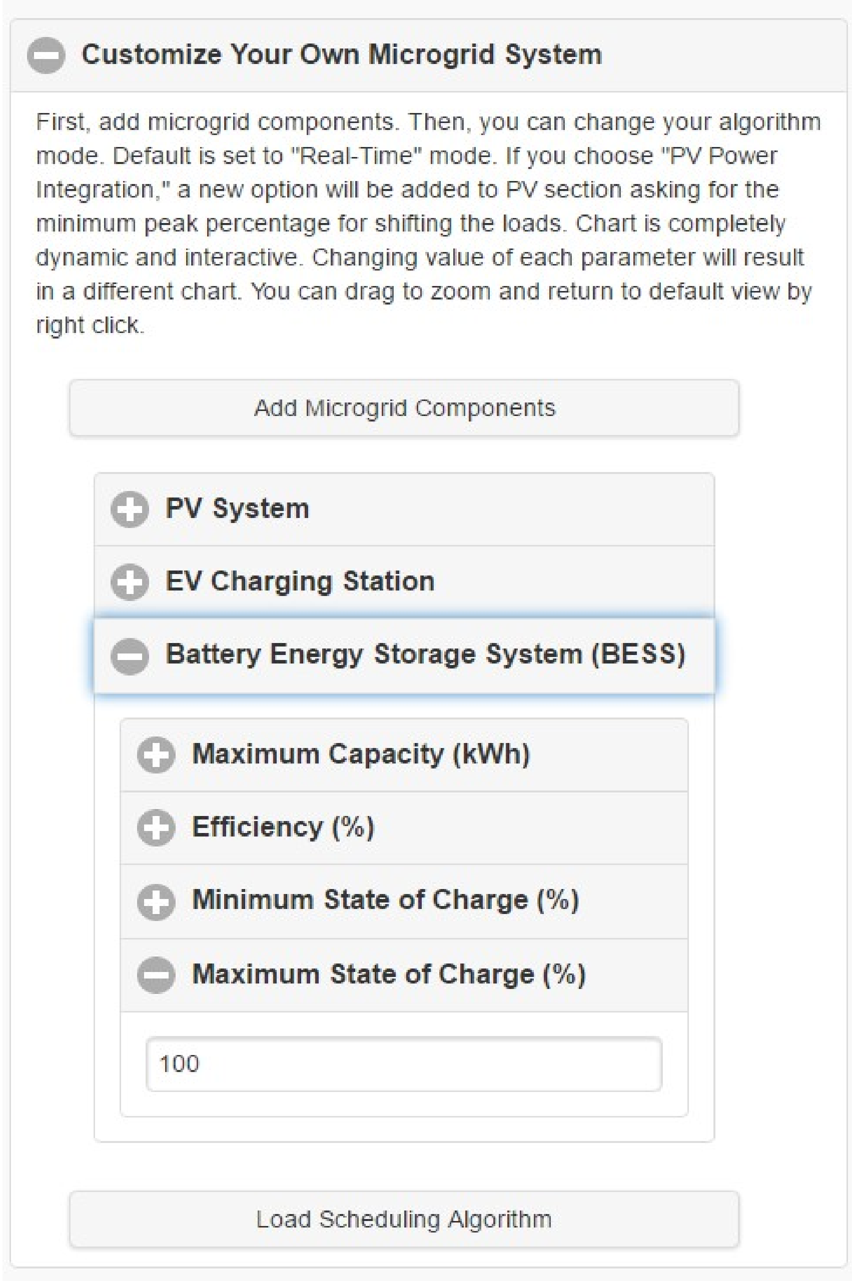
- Nominal Capacity: 62 kWh
- Nominal Power: 30 kW
- Maximum output Energy: 5kwh or 10kwh

Simulate Page Front-End & Back-End Design

Front-End Design

Figure 43 shows the webpage interface for the Battery Energy Storage System. The user will input the maximum output energy for the battery.

Figure 43: Battery Energy Storage System Webpage Details



Source: Los Angeles Economic Development Corporation

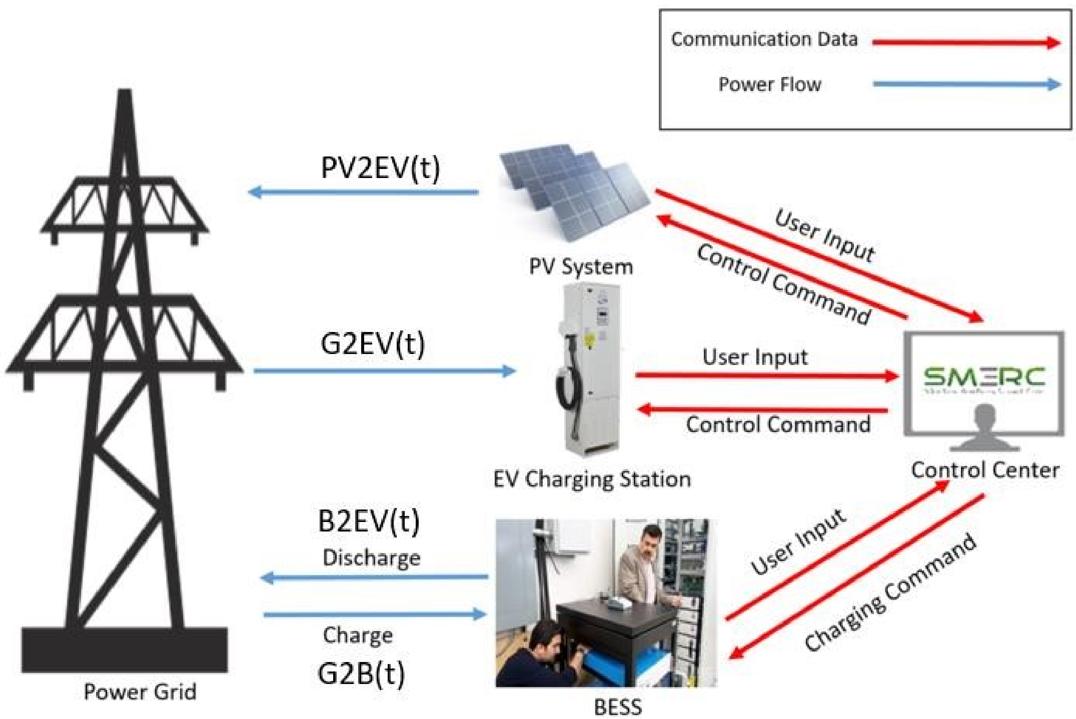
- Maximum Output Energy
- Efficiency
- Minimum State of Charge
- Maximum State of Charge

Control System

Background & System Architecture

The control center coordinates the energy resources located on University of California, Los Angeles campus, including EV charging stations, Photovoltaic system at the Ackerman Union and Battery Energy Storage System. In other words, the control center controls Photovoltaic System, Battery Energy Storage System and EV Charging Station after taking user's input simulation parameters to have the most optimal and efficient simulation results (e.g. peak reduction) (showing in section 4. Simulation). To be more specific, the overall goal of the control system is to reduce the EV system demand by managing energy feed from Photovoltaic system and Battery Energy Storage System optimally. In other words, the control system will try to utilize the energy from Photovoltaic system, Battery Energy Storage System (if possible) to satisfy the EV system demand. Lastly, it would utilize the energy from grid to meet the remaining EV demand. Figure 44 shows the control center configuration.

Figure 44: Control Center Figuration



Source: Los Angeles Economic Development Corporation

System Assumption

There are three assumptions that the control center needs to satisfy in order to have optimal simulation results:

1. There is always demand for EV. In other words, the user will always select one of the EV system conditions.
2. Battery Energy Storage System cannot put extra power into grid. However, Photovoltaic system can generate extra power and extra power goes to grid.
3. Battery Energy Storage System cannot be charged and discharged at the same time interval: [t,t+1].

Problem Formation

The problem formation is shown in Figure 45:

Figure 45: Problem Formation

$$\text{Minimize} \qquad G2EV(t)$$

$$\text{s.t.} \quad EV(t) = PV2EV(t) + B2EV(t) + G2EV(t)$$

$$PV(t) = PV2EV(t) + (x^c(t) \times PV2B(t))$$

$$B2EV(t) = \frac{x^d(t) \times BE(t)}{BCS}$$

$$BE(t+1) = BE(t) + \frac{(x^c(t) \times PV2B(t) + G2B(t))}{BCS}$$

$$x^c(t) + x^d(t) \leq 1$$

$$x^c(t) \in \{0,1\}, x^d(t) \in \{0,1\}$$

$$PV2EV(t) \in R_{\geq 0}, B2EV(t) \in R_{\geq 0}, G2EV(t) \in R_{\geq 0}, EV(t) \in R_{\geq 0}$$

$$BCS \in R_{>0}, \mathrm{BE}(t) \in R_{\geq 0}, \mathrm{PV}(t) \in R_{\geq 0}, \mathrm{EV}(t) \in R_{\geq 0}$$

BE(t) – Current Battery Energy Storage System energy, PV(t) – Photovoltaic power generation at time t, EV(t) – EV demand at time t, B2EV(t) – Battery Energy Storage System to EV power flow at time t, G2B(t) – Grid to battery power flow at time t, G2EV(t) – Grid to Battery Energy Storage System power flow at time t, PV2EV(t) – Photovoltaic system to EV system power flow at time t, PV2B(t) – Photovoltaic system to Battery Energy Storage System power flow at time t

Source: Los Angeles Economic Development Corporation

System Logic & Flowchart

The output of the control system is divided based on user inputs:

1. User selection: only EV system. In this case, all the EV demand is satisfied by the grid. In other words, the grid will feed all the EV demand.

2. User selection: EV system + Battery Energy Storage System. In this case, the control system will check the following 2 thresholds and then output correspondingly. The output results are shown in Table 7.

Table 7: Control Center Output (EV + Battery Energy Storage System)

Threshold 1	Threshold 2	System Output
Battery is dead: $\boldsymbol{BE(t) = 0}$	N/A	Grid feeds all EV demand: $G2EV(t) = EV(t)$ Grid charges Battery Energy Storage System: $G2B(t) = \frac{BC}{BCS}$ $BE(t+1) = BE(t) + G2B(t)$
Battery has energy: $\boldsymbol{BE(t) > 0}$	Battery Energy Storage System can only satisfy part of EV demand: $\frac{EV(t)}{BCS} \geq BE(t)$	Battery Energy Storage System feeds part of EV demand: $B2EV(t) = \frac{BE(t)}{BCS}$ Grid feeds the remaining part of EV: $G2EV(t) = EV(t)$
	Battery Energy Storage System can feed all of EV demand: $\frac{EV(t)}{BCS} < BC - BE(t)$	Battery Energy Storage System feeds all EV demand: B2EV(t)=EV(t)

Source: Los Angeles Economic Development Corporation

1. User selection: EV System + Photovoltaic System

The outputs are shown in Table 8.

Table 8 Control Center Output (EV + Photovoltaic)

Threshold	System Output
Photovoltaic power generation is greater than EV demand at time t: $\boldsymbol{EV}(\mathrm{t}) \leq$ PV(t)	Photovoltaic feeds all EV demand: $PV2EV(t) = EV(t)$
Photovoltaic power generation is greater than EV demand at time t: $\mathbf{EV}$(t) $\geq$ PV(t)	Photovoltaic feeds part of EV demand: $PV2EV(t) = PV(t)$ Grid feeds the remaining part of EV: $G2EV(t) = EV(t)$

Source: Los Angeles Economic Development Corporation

1. User selection: EV System + Photovoltaic System + Battery Energy Storage System

The outputs are shown in Table 9.

Table 9: Control Center Output (EV + Battery Energy Storage System + Photovoltaic)

<table>
<tr><th>Threshold 1</th><th>Threshold 2</th><th>Threshold 3</th><th>System Output</th></tr>
<tr><td rowspan="2">Photovoltaic power generation is greater than EV demand at time t:

$\boldsymbol{EV(t) < PV(t)}$</td><td>The remaining Photovoltaic power is NOT enough to charge Battery Energy Storage System from t to (t+1):
$PV(t) < \frac{BC - BE(t)}{BCS}$</td><td>N/A</td><td>Photovoltaic feeds all EV demand:
$PV2EV(t) = EV(t)$
Remaining Photovoltaic power charges part of Battery Energy Storage System needs, grid charges the rest part of Battery Energy Storage System needs:
$PV2B(t) = PV(t)$
$G2B(t) = (BC - BE(t))/BCS$</td></tr>
<tr><td>The remaining Photovoltaic power is enough to charge Battery Energy Storage System from t to (t+1):
$PV(t) \geq \frac{BC - BE(t)}{BCS}$</td><td>N/A</td><td>Photovoltaic feeds all EV demand:
$PV2EV(t) = EV(t)$
Remaining Photovoltaic power charges all Battery Energy Storage System needs:
$PV2B(t) = (BC - BE(t))/BCS$</td></tr>
<tr><td rowspan="2">Photovoltaic power generation is NOT greater than EV demand at time t:

$\boldsymbol{EV}(t) \geq PV(t)$</td><td rowspan="2">The remaining EV demand cannot be satisfied by Battery Energy Storage System from t to (t+1):
$BE(t) \geq \frac{EV}{BCS}$</td><td>Battery Energy Storage System has energy:
$BE(t) > 0$</td><td>Photovoltaic feeds part of EV demand:
$PV2EV(t) = PV(t)$
Battery Energy Storage System feeds another part of EV demand:
$B2EV(t) = BE(t)$ Grid feeds the rest of EV demand:
$G2EV(t) = EV(t)$</td></tr>
<tr><td>Battery Energy Storage System has no energy:
$BE(t) \leq 0$</td><td>Photovoltaic feeds part of EV demand:
$PV2EV(t) = PV(t)$
Grid feeds the rest of EV demand:
$G2EV(t) = EV(t)$ Grid Charges Battery Energy Storage System:
$G2B(t) = (BC - BE(t))/BCS$</td></tr>
</table>

Threshold 1	Threshold 2	Threshold 3	System Output
	The remaining EV demand can be satisfied by Battery Energy Storage System from t to (t+1):	N/A	Photovoltaic feeds part of EV demand: $PV2EV(t) = PV(t)$ Battery Energy Storage System feeds the rest part of EV
	$BE(t)$ $EV(t) <$ BCS		demand: $B2EV(t) = EV(t)$

Source: Los Angeles Economic Development Corporation

1. Special case: when EV demand equals to 0. (User has chosen EV system, but there is some duration of EV demand is zero)

The outputs are shown in Table 10.

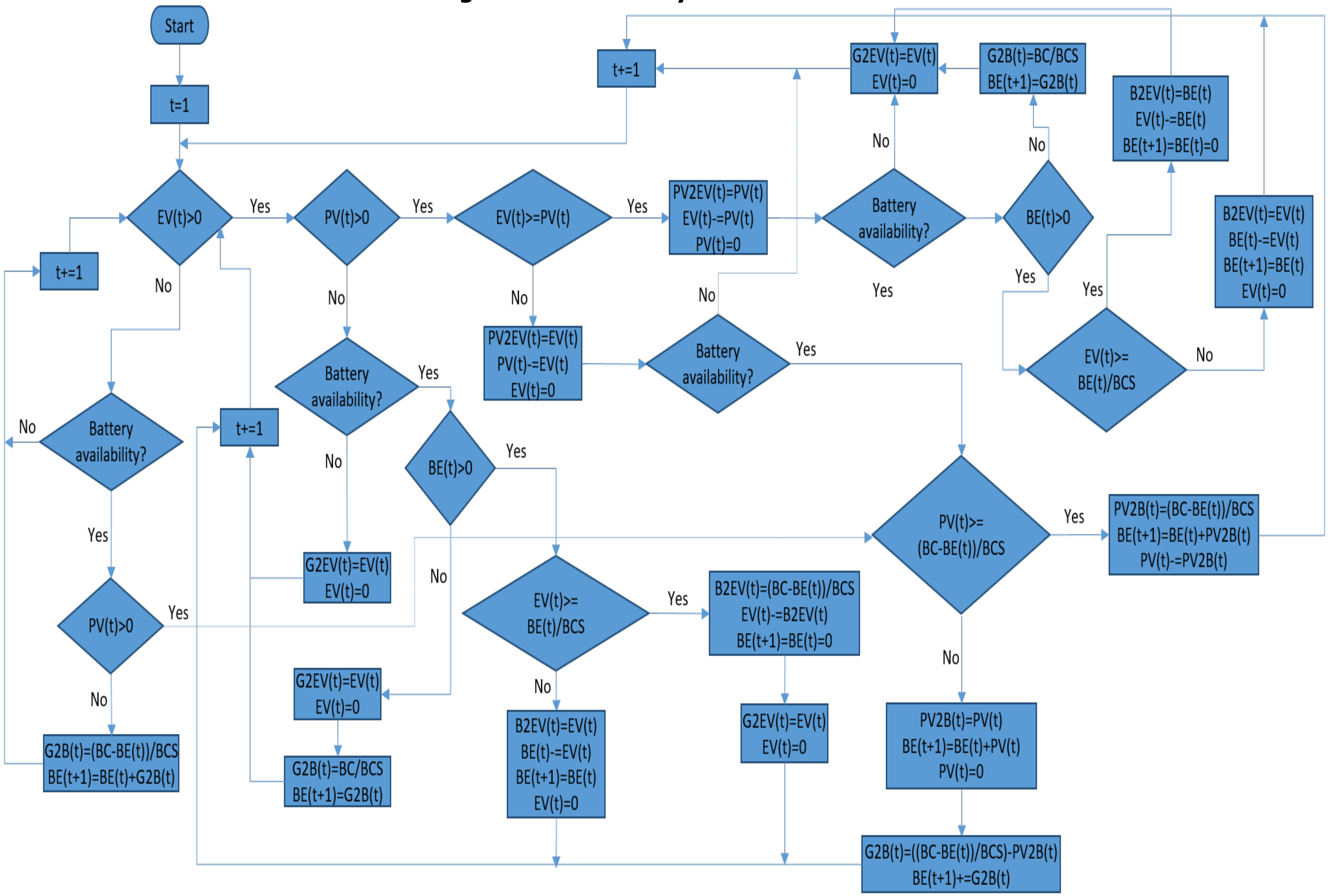
Table 10: Control Center Output (Special Case)

	Battery Energy Storage System	PV(t)	If Photovoltaic can fully charge Battery Energy Storage System in next time interval: $\mathbf{PV}(t) \geq \frac{BC - BE(t)}{\mathbf{BCS}}$	System Output
the time duration where there is no EV demand: $\boldsymbol{EV(t) = 0}$	NOT selected	N/A	N/A	Update t to next interval: t = t+1
	Selected	NOT Selected	N/A	Grid charges Battery Energy Storage System (if necessary): G2B(t) = (BC − BE(t))/BCS
		Selected	YES	Photovoltaic charges all Battery Energy Storage System needs: PV2B(t) = (BC − BE(t))/BCS
			NO	Photovoltaic charges part of Battery Energy Storage System needs: PV2B(t) = PV(t) Grid charges rest part of Battery Energy Storage System needs: G2B(t) = ((BC − BE(t))/BCS) − PV2B(t)

Source: Los Angeles Economic Development Corporation

The following flowchart was drawn based on the logic flow above. Figure 46 shows the flow chart of control system.

Figure 46: Control System Flow Chart



Source: Los Angeles Economic Development Corporation

Simulation Setup and Analysis

A group of simulation scenarios are given in this section. These scenarios will help users have better understanding about the simulation results as well as studying the whole system from various perspectives.

Simulation Example 1

User Input

The following conditions shown in Table 11 will be the same through the whole simulation.

Table 11: User Input

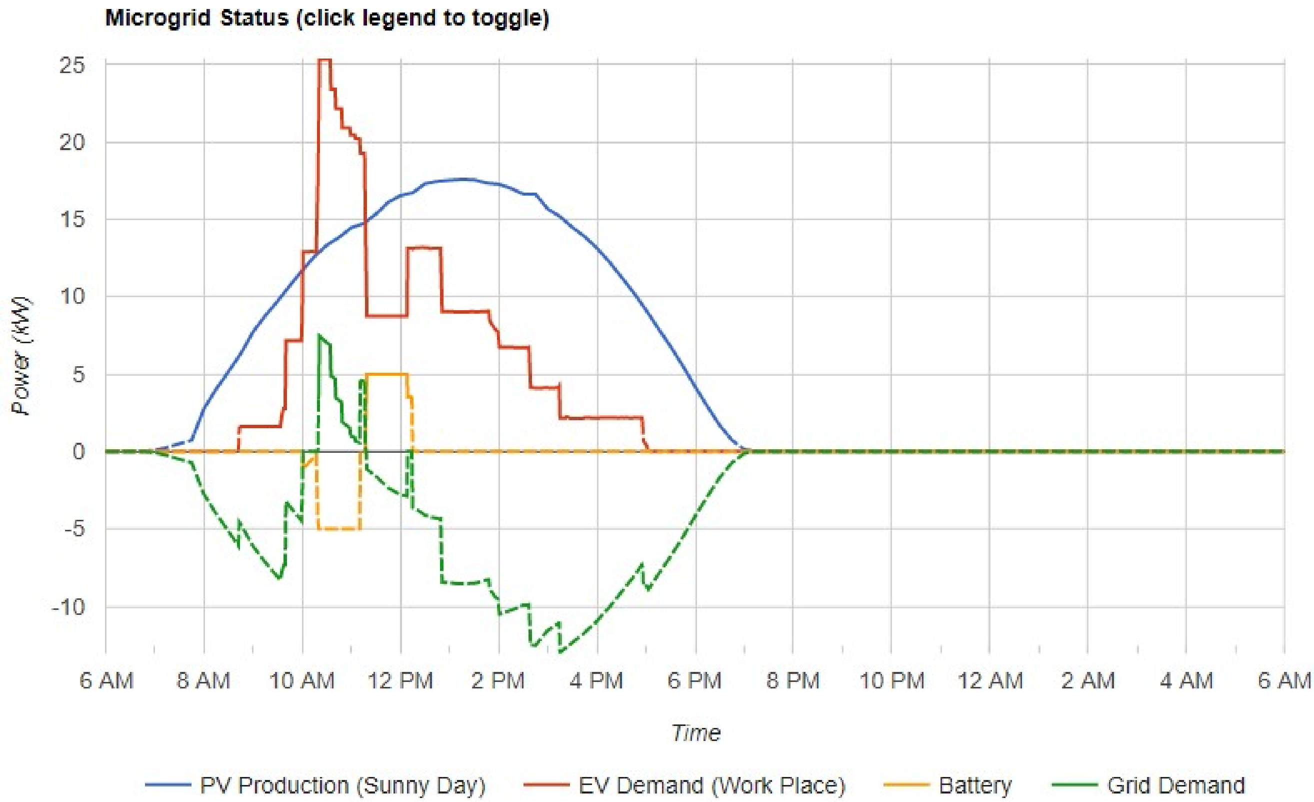
Photovoltaic	Weather Condition	Sunny
	Nominal Power Output	20 kW
EV	EV charging Station environment	Workplace
	No. of Charging Station	5
Battery Energy Storage System	Capacity	5 kwh
	Efficiency	100%
	Minimum SOC	10%
	Maximum SOC	100%

Source: Los Angeles Economic Development Corporation

Simulation Results

Figure 47 shows the simulation results for a sunny day.

Figure 47: Sunny Day Results

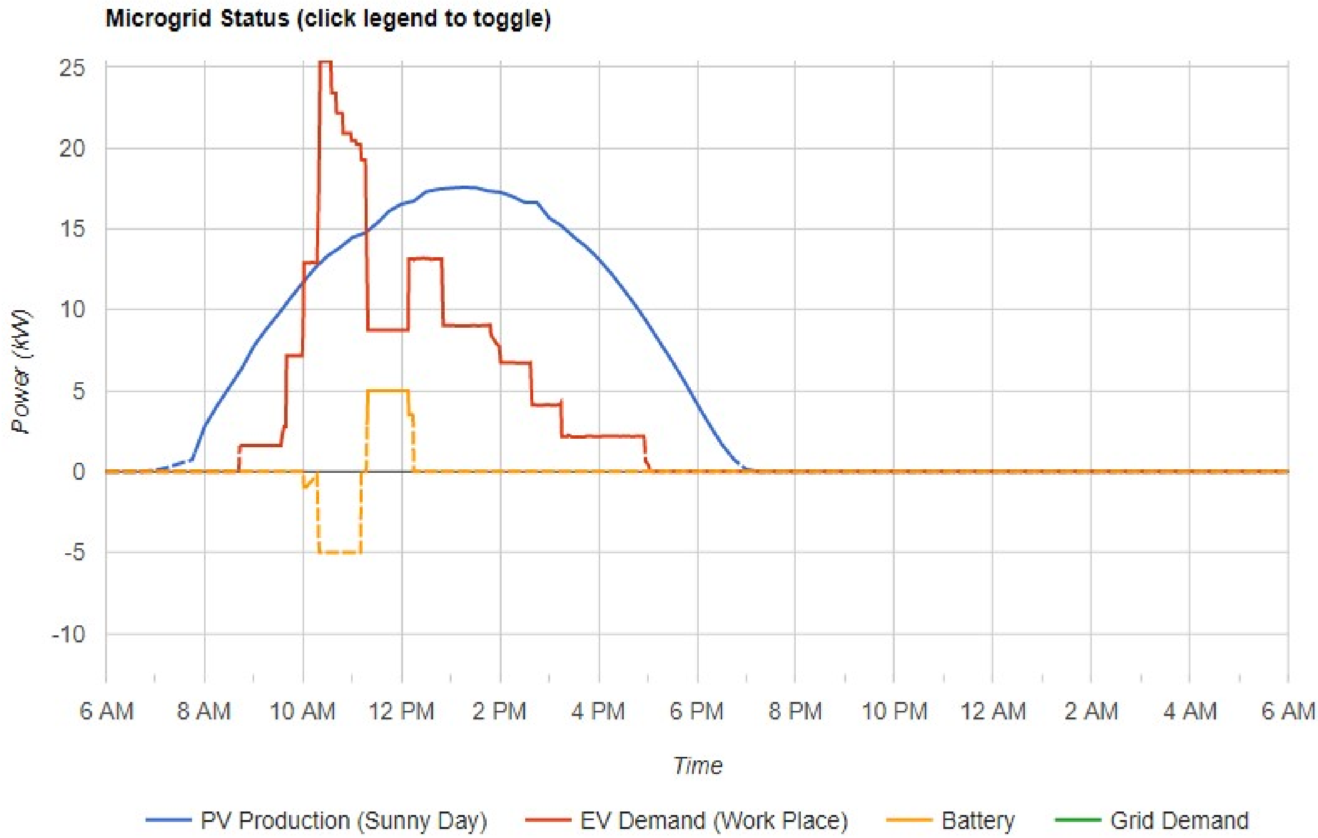


Source: Los Angeles Economic Development Corporation

The simulation above starting from 6am to the next day 6am. The blue line represents the Photovoltaic production and the red line represents the EV Demand. From 6am to 8:42am, there is no EV demand during this time but Photovoltaic production only. Thus, the Photovoltaic power production will go to the grid directly, and we see a negative grid demand (green line) on the simulation plot. From 8:42am to 10:01am, there are both Photovoltaic production and EV demand, and the EV demand is less the Photovoltaic production. During this time, the Photovoltaic production is sufficient to satisfy all the EV demand. From 10:01am to 11:17am, the Photovoltaic production now is smaller than the EV demand. Thus, all the Photovoltaic power is used to satisfy the EV demand while the battery (yellow line) completely discharges in 61 minutes to supply the EV demand. However, in this situation, we still cannot satisfy all the EV demand, thus we must borrow from power from grid. Beyond 11:17am for the rest of the day, the Photovoltaic Production is again greater than the EV Demand. This leads to the battery recharging to its full capacity again from 11:17am to 12:15pm.

It is also possible to toggle specific plot lines ON and OFF by clicking on the legends on the plot. In this case, if we click on "Grid demand" at the bottom of the plot, the green line disappears, shown in Figure 48. Clicking on it again will make it re-appear.

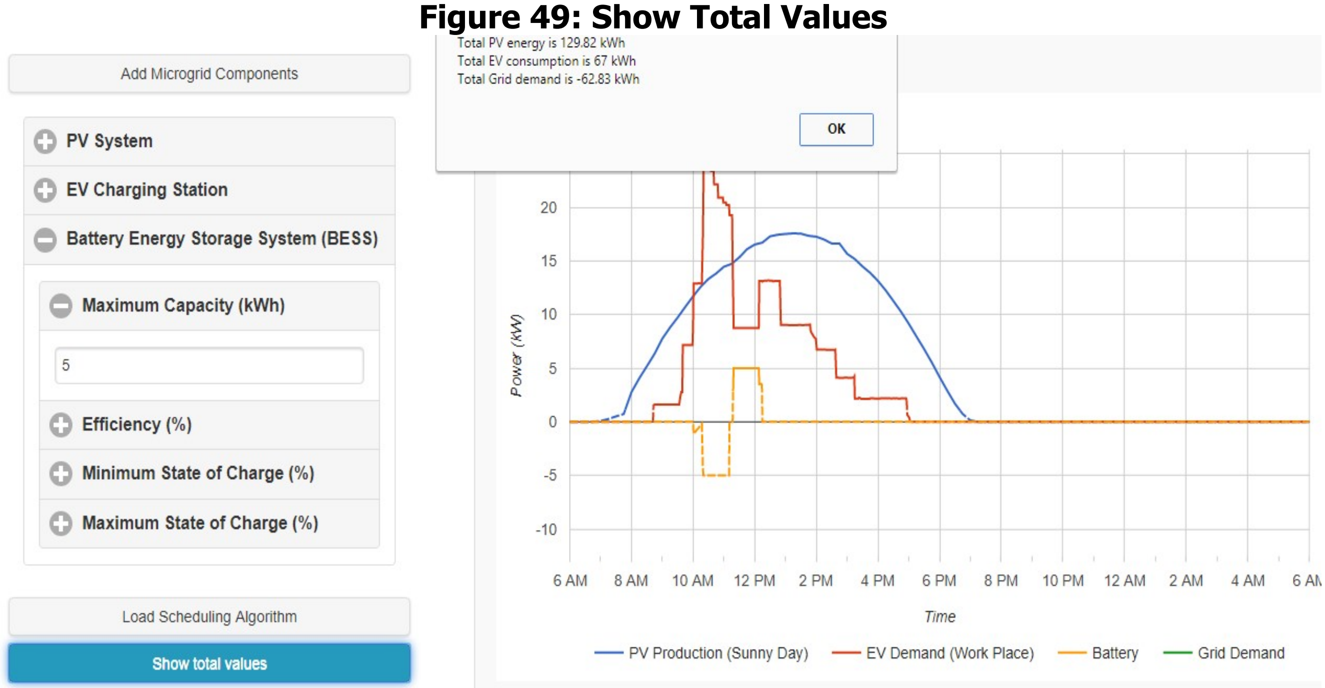
Figure 48: Toggling Plot Lines with Simulation Results



Source: Los Angeles Economic Development Corporation

Also, by clicking on the "Show total values" button, we receive a message box showing the values of Total Photovoltaic energy, Total EV consumption and Total grid demand, shown in Figure 49.

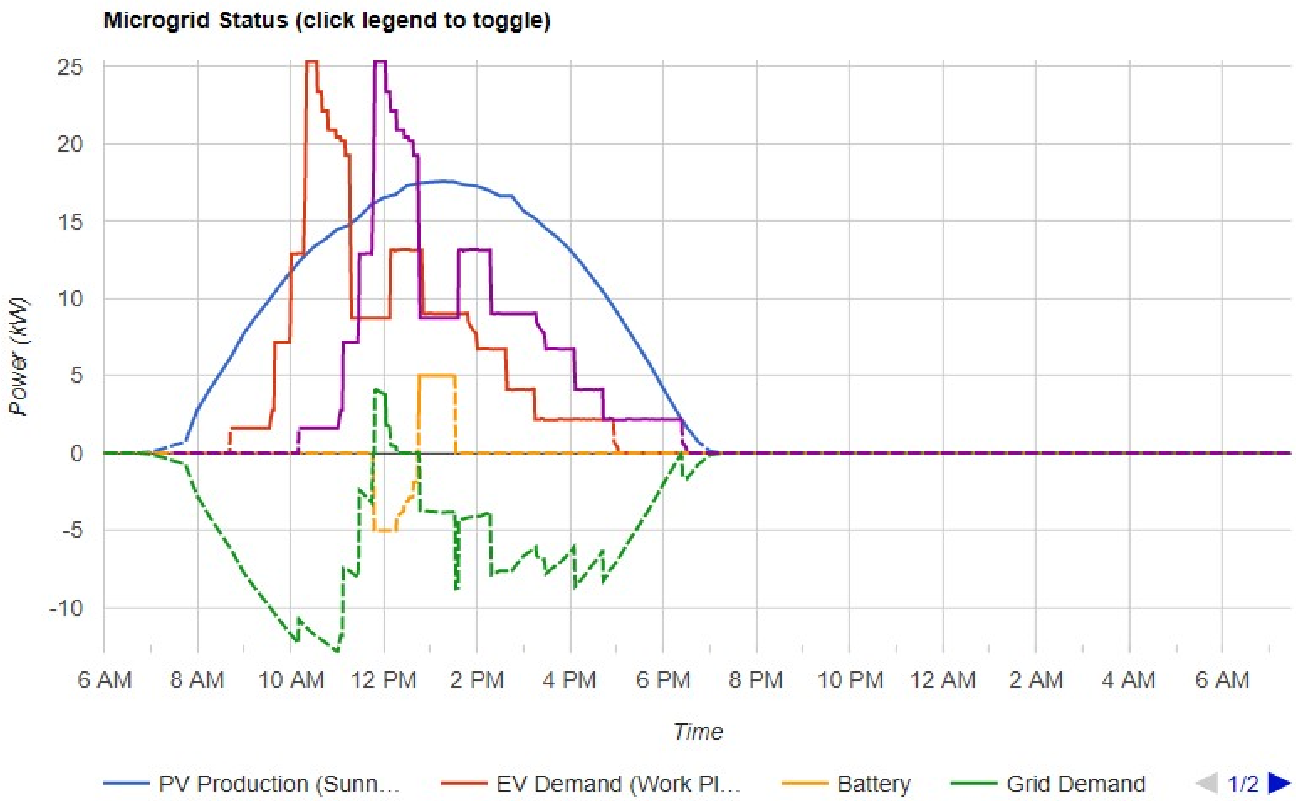
Figure 49: Show Total Values



Source: Los Angeles Economic Development Corporation

The following simulation plot, shown in Figure 50, shows when the user input is the same, changing the Load Scheduling Algorithm to Photovoltaic Power Integration with minimum peak percentage for shifting to be 70 percent. The purple line is the shifted EV Demand.

Figure 50: Simulation Results



Source: Los Angeles Economic Development Corporation

The analysis is the same, the only change from previous simulation result is that the control system will start to satisfy EV demand when the Photovoltaic reaches 70 percent of its maximum output.

Simulation Example 2

User Input

The following conditions shown in Table 12 will be the same through the whole simulation.

Table 12: User Input

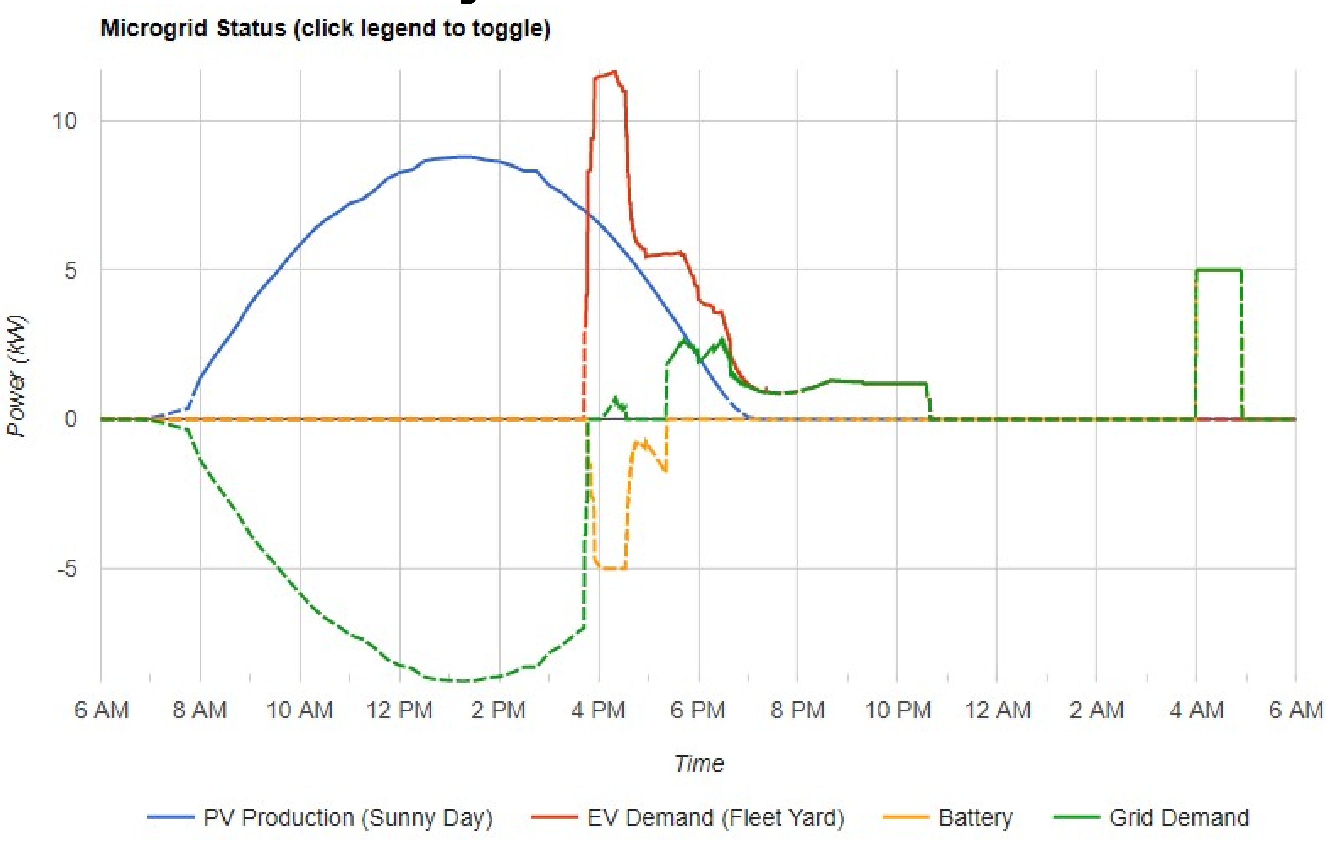
Photovoltaic	Weather Condition	Sunny
	Nominal Power Output	10 kW
EV	EV charging Station environment	Fleet Yard
	No. of Charging Station	5
Battery Energy Storage System	Capacity	5 kwh
	Efficiency	100%
	Minimum SOC	10%
	Maximum SOC	100%

Source: Los Angeles Economic Development Corporation

Simulation Results

From 3:42pm to 7:14pm we have both Photovoltaic production and EV demand, and EV demand is always greater than the Photovoltaic production. Thus, in the simulation plot at this time duration, shown in Figure 51, all the Photovoltaic production is used to satisfy EV demand and we must borrow power from the battery and the grid to satisfy the remaining EV demand. The battery completely discharges between 3:46pm and 4:22pm. It will be fully charged from 4am to 5am the next day borrowing power from the grid.

Figure 51: Simulation Results



Source: Los Angeles Economic Development Corporation

Summary

This report for Online Training Center introduced the background and function for EV charging system, Photovoltaic system, BSEE, as well as the control center. This Online Training Center is an interactive tool for users to have a better understanding about microgrid integration among EV system, Photovoltaic system, and Battery Energy Storage System through a vivid simulation plot.

References

1. J. Todd, J. Chen and F. Clogston, "Creating the Clean Energy," International Economic Development Council, Washington, DC, 2013.
2. MIT Electric Vehicle Team, "A Guide to Understanding Battery Specifications," [Online]. Available: http://web.mit.edu/evt/summary_battery_specifications.pdf.
3. Ilumen, "The difference between nominal and real PV power explained," available at http://www.ilumen.be/en/the-difference-between-nominal-and-real-pv-power-explained/.

Appendix C:
Los Angeles Economic Development Corporation Presentation

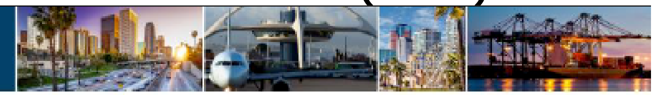
Figure 52 shows the Los Angeles Economic Development Corporation's PowerPoint presentation entitled the "Promise of Southern California for Alternative Vehicles."

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation

Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)

LAEDC **The Promise of Southern California for AVs**



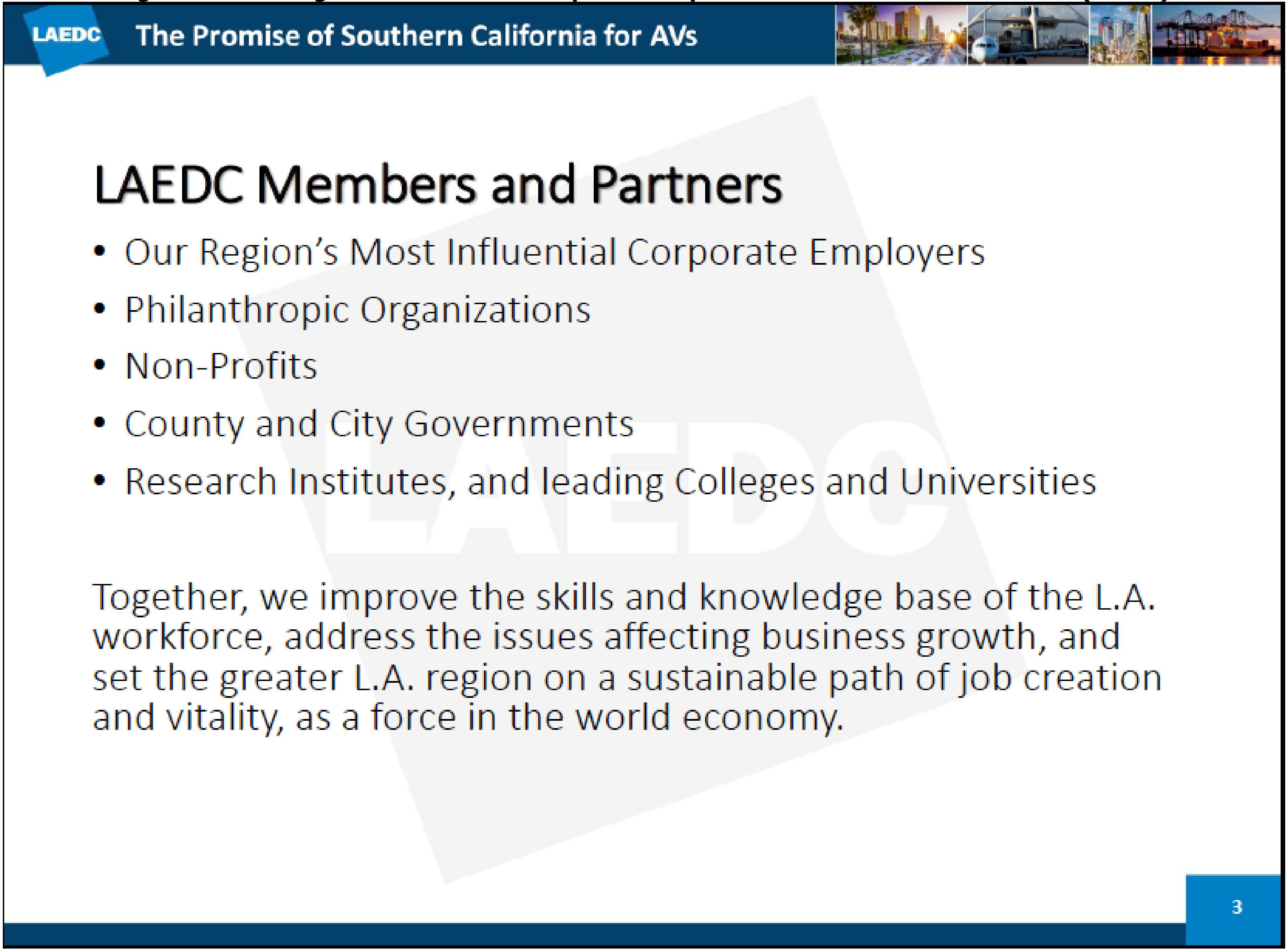
LAEDC's History The LAEDC is private, non-profit organization economic development organization established in 1981 by the LA County Board of Supervisors. The LAEDC was originally formed to facilitate LA County's industrial bond development program through land development, project financing and marketing activities. Since that time, the organization has grown to encompass a wide range of services, using a broad-based coalition of chambers of commerce, trade organizations, business associations and government officials.

Purpose LAEDC's purpose is to raise standards of living for all LA County residents by increasing economic opportunity and regional prosperity

2

Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)



Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)

LAEDC **Official Comments To VW Electrify America**

Major Programs

- Business Assistance
- Initiatives (e.g. Advanced Transportation Center)
- Real Estate Services
- World Trade Center LA
- Public Policy

4

Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)

Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)

LAEDC Official Comments To VW Electrify America

ADVANCED TRANSPORTATION CENTER of Southern California

e4 economy energy efficiency environment

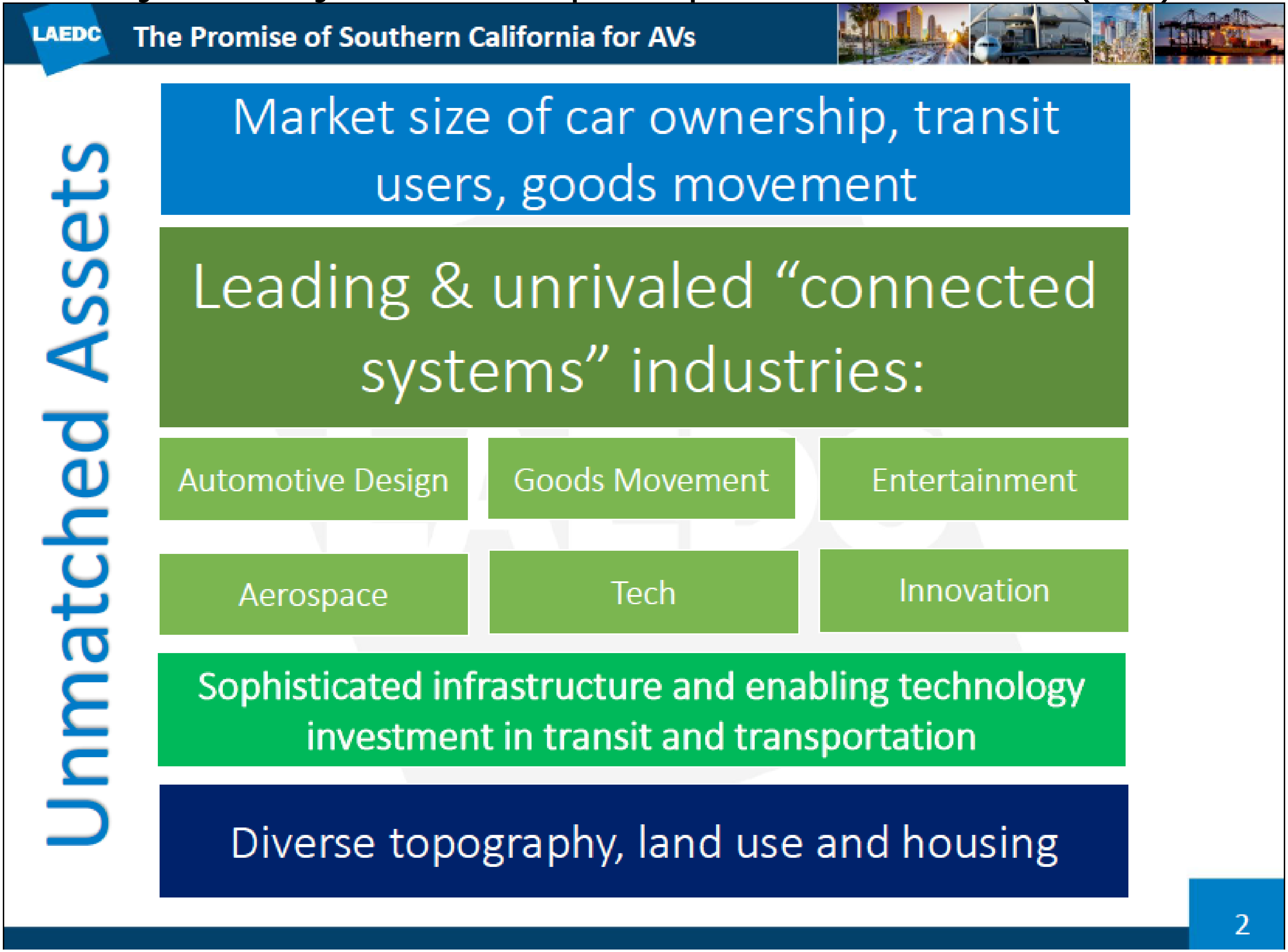
Major Programs

- e4 Mobility Alliance
- Three physical walk-in centers for fleets, industry and general public (LACI, Cleantech OC, and Center for Sustainable Energy)
- Advanced Transportation Center Advisory Council
- Policy and Funding Calls

6

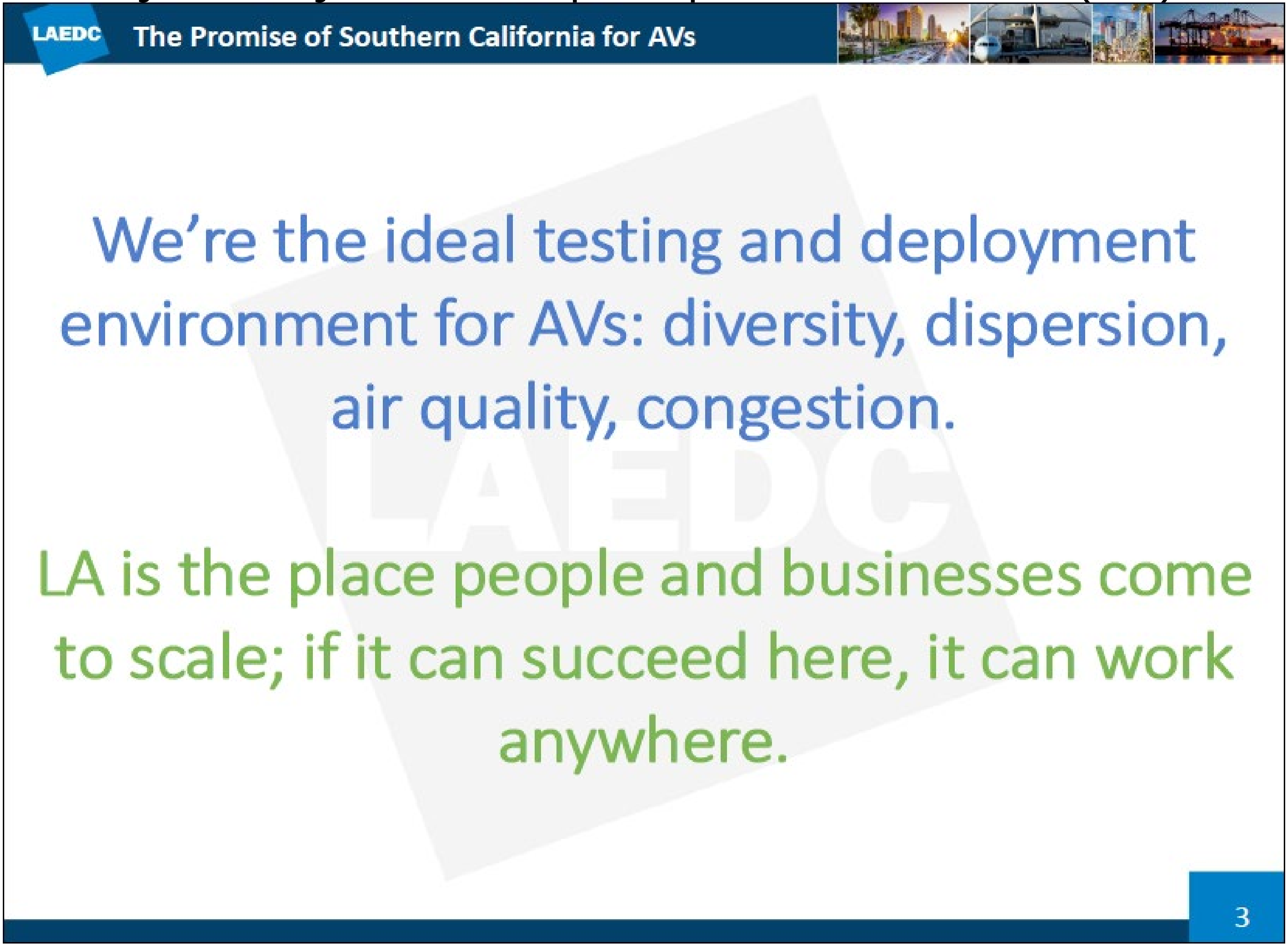
Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)



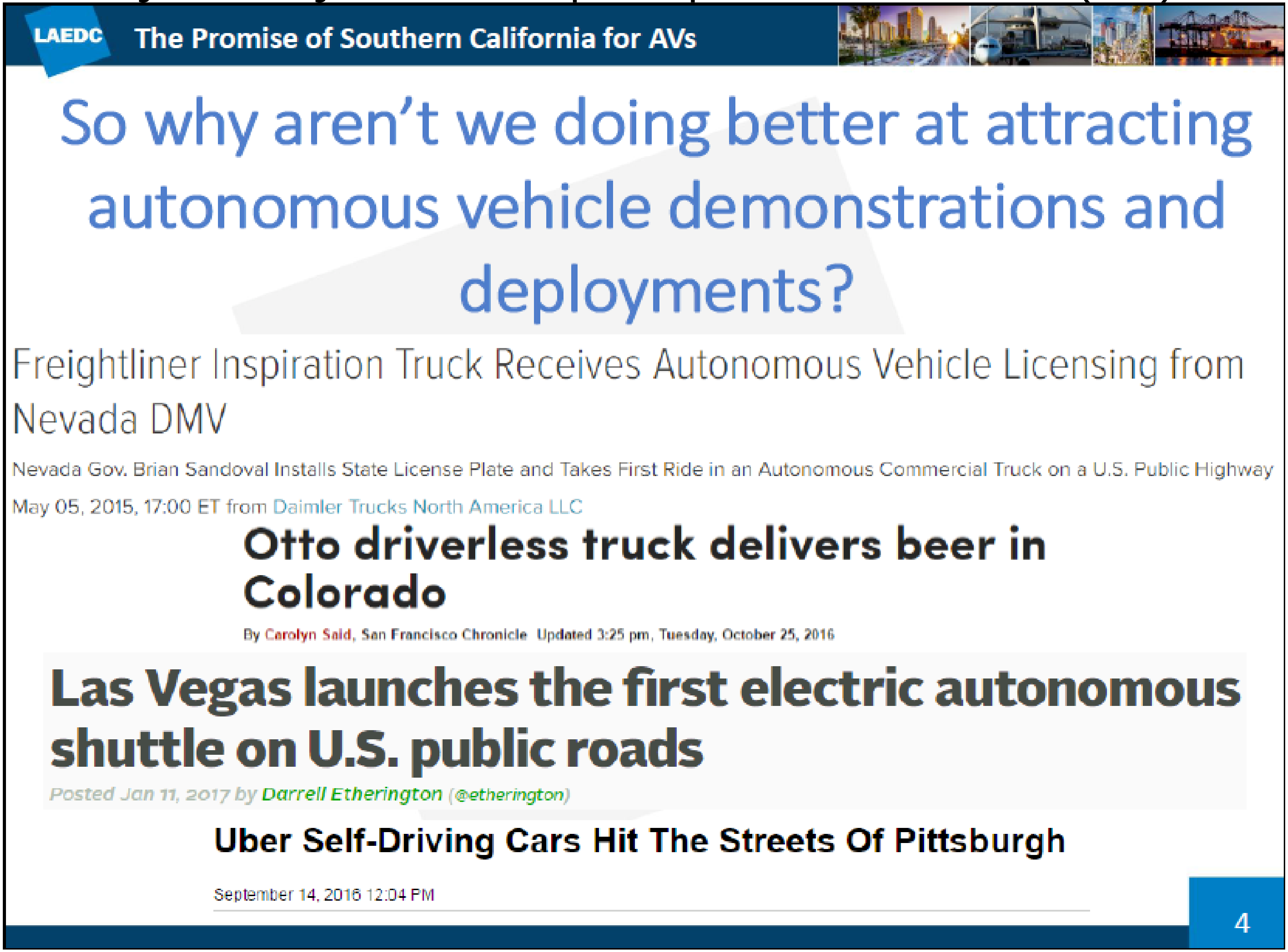
Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)



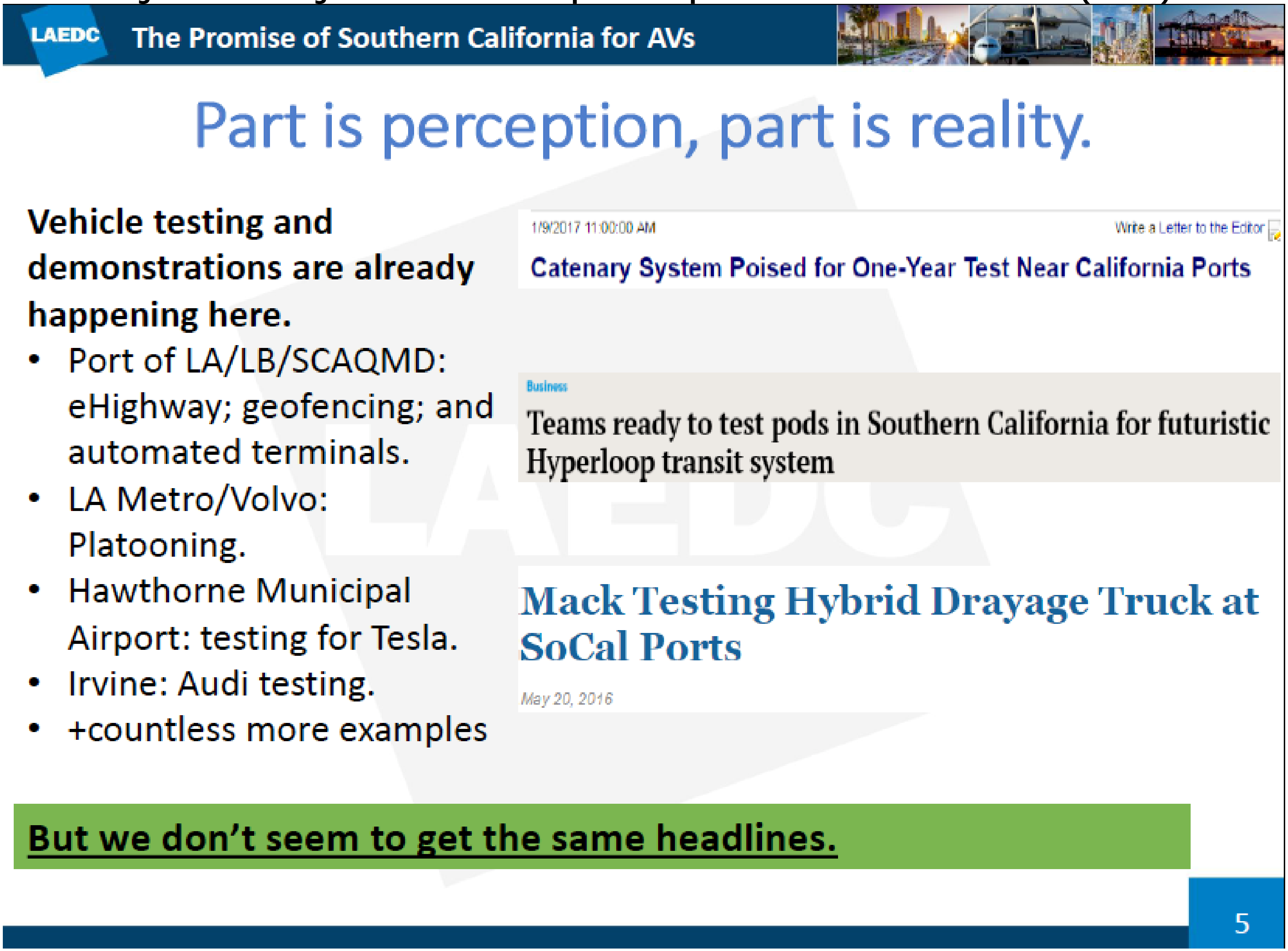
Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)



Source: Los Angeles Economic Development Corporation

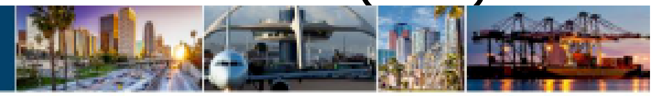
Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)



Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)

LAEDC The Promise of Southern California for AVs



So what can we do to improve the trajectory going forward for AVs in SoCal?

Key Strengths:

- We have the capability to do vehicle demonstrations—except for some pesky state laws for vehicles over 10,000lbs on public streets.
- We have public agencies willing to work on these issues in much of Southern California—providing different venues in case one place doesn't work.

Key Weaknesses:

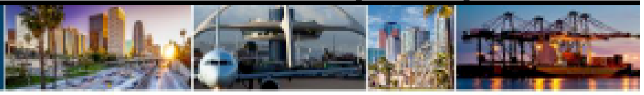
- We don't have a simple mechanism for people to find out where and how these can be done. **How do we roll out the red carpet?**
- We lack the concentrated marketing and outreach to let people know these things are happening.

11

Source: Los Angeles Economic Development Corporation

Figure 52: Los Angeles Economic Development Corporation PowerPoint Presentation (cont'd)

LAEDC The Promise of Southern California for AVs



Next Steps

- MOU to work cooperatively with one another where agencies and sites have a seat at the table.
  - If it can't happen in city XYZ, we should be committed to having it happen elsewhere in Southern California and knowing how to facilitate that.
- Ordinances & best practices development to facilitate AVs from a regulatory and permitting perspective
- Site location aggregator and website for facilitating AVs.
  - Similar to http://www.locoscout.com/ & http://ca.reel-scout.com/loc.aspx
- Site information:
  - Type: public/private
  - Size
  - Address
  - Contact details
  - Cost details
  - Sector serviced: goods movement, transit, personal mobility, other
  - Permit requirements
- Marketing tools to spread awareness

12

Source: Los Angeles Economic Development Corporation