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Achieving Zero-Emission Mobility: The Role of Innovative Electric Vehicle Companies

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Achieving Zero-Emission Mobility: The Role of Innovative Electric Vehicle Companies

Final Report UCCONNECT 2016

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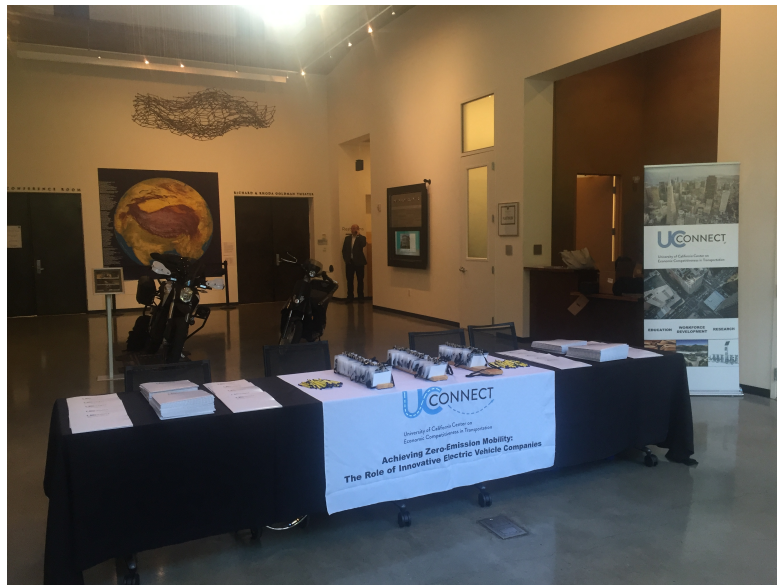
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Executive Summary

On April 28, 2016, UCONNECT hosted a symposium in Berkeley, CA on ***Achieving Zero-Emission Mobility: The Role of Innovative Electric Vehicle Companies***. The symposium provided a platform for innovative and trendsetting electric vehicle (EV) companies to explain their latest business models and show how they can add value and contribute to the national dialogue on the transformation needed to achieve zero-emission transportation. Focus was also placed on identifying strategies that could potentially broaden the clean-transportation conversion by increasing “zero-emission vehicle” (ZEV) access to all income groups.

In recent years, the U.S. Departments of Transportation (DOT) and Energy (DOE), as well as various state agencies, have been prioritizing the development and adoption of ZEVs. This has largely been framed in the broader, national and international effort to bring Greenhouse Gas (GHG) emissions under control, as pledged by President Obama at the 2015 United Nations Framework Convention on Climate Change, and resulted in “the Paris Agreement.”. This agreement has not yet been brought into full force but has been ratified by 19 countries with 178 total nations as signatories, and is designed to limit future climate change to an average global temperature rise of 1.5-2.0 °C.¹

As of 2014, the transportation sector of the US economy contributed roughly over one-fourth of the total GHG emissions (<https://www3.epa.gov/climatechange/ghgemissions/sources.html>), closely following the electricity production sector. The reason behind this is the extensive use of fossil fuel by the automotive fleet. Thus, as energy production increases the use of alternative and renewable sources, so must the transportation sector transition to adopt cleaner more sustainable vehicles that rely less on conventional fuels.

In this vein, the DOT and DOE have collaborated on several programs and initiatives including the *EV Everywhere Program*, announced by President Obama in 2012. The program’s goal is to increase the adoption of plug-in electric vehicles across the U.S, and to do so through research and development, outreach and education, and partnership building.

However, efforts to promote the adoption of EVs do not stop at the federal level. As of 2015, more than 37 states and the District of Columbia have adopted incentives that are aligned with the goal of increasing EV market uptake.² These mechanisms include providing high-occupancy vehicle (HOV) lanes access exemptions, financial incentives such as tax credits or registration fee reductions, parking payment exemptions, etc. These incentives, moreover, apply to diverse vehicle types, from small two-wheel EVs to heavy duty electric trucks. In California, as noted in the 2015 California Zero Emission Vehicle Action Plan, Governor Jerry Brown signed the “Charge Ahead California Initiative” in 2014 with the rationale that “all communities in California should have access to ZEVs and low-emission transportation and the many benefits of these technologies should be shared statewide.” The initiative directs the California Air Resources Board to develop a forward looking funding plan to meet the goal of 1 million ZEVs on California roads by 2020, while ensuring disadvantaged, low-income, and moderate-income communities benefit from this transition.

The symposium sought to build on these initiatives and stated visions by laying out where and how significant advances can be made to meet our common goals of economic efficiency and sustainability for the transportation sector.

¹ "Paris Agreement, FCCC/CP/2015/L.9/Rev.1" UNFCCC secretariat.

² See <http://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx> for additional information.



Opening Session: Overarching Perspectives



Moderator

Kevin Womack, Director, Transportation Safety Institute, Office of the Assistant Secretary for Research and Technology, U.S. Department of Transportation

Kevin Womack provides his leadership to develop and mentor professional staff, and fosters collaboration among researchers, program managers and agencies across the U.S. DOT and with external stakeholders.

Speakers



Austin Brown, Senior Policy Analyst, White House Office of Science and Technology Policy

Austin Brown's work focuses on technologies and policies for clean energy and sustainable transportation. His primary career interest is to see the United States begin on a pathway that leads towards a future where energy is clean, affordable, and reliable domestically and worldwide.



Marlon Flournoy, Acting Assistant Director of Sustainability, California Department of Transportation

Marlon Flournoy manages all phases of the District's Division of Transportation Planning and Local Assistance, which includes designing an efficient and effective functional organization, allocating resources within the Division. In addition, he develops program objectives and closely monitors program delivery.



Jay Friedland, Vice President of Strategy and Sustainability, Zero Motorcycles Inc. and Senior Policy Advisor for Plug In America

Jay Friedland is working to accelerate the adoption of plug-in electric vehicles powered by clean, affordable, domestic electricity to reduce our nation's dependence on petroleum and improve the local and global environment.



Christine Harada, Federal Chief Sustainability Officer, White House Council on Environmental Quality, Office of Federal Sustainability

Christine Harada is primarily responsible for promoting environmental and energy sustainability across the Federal Government operations.



Jeff Marootian, *Assistant Secretary for Administration, US Department of Transportation*

Jeff Marootian oversees workforce development for the 55,000 employee agency. Mr. Marootian directs the implementation of President Obama's energy, environmental and sustainability goals.



Reuben Sarkar, *Deputy Assistant Secretary for Transportation, U.S. Department of Energy*

Reuben Sarkar is in charge of the annual investment of more than \$600 million with a focus on reducing US oil dependency, avoiding pollution, and creating jobs by designing and manufacturing petroleum alternatives and more energy efficient cars and trucks.

Session Summary

The discussion in this panel brought new perspectives to the topic of vehicle electrification based on the emergence of small innovative EV companies and the technological improvements that have taken place in recent years. The main issues covered in the panel revolved around challenges that these EV companies face, including battery costs and policy-related topics, such as how to increase the inherent value of EVs for consumers through regulation.

Panelists also discussed the importance of connecting people with economic opportunities through alternative mobility options. Attention was directed toward expanding access to public transportation by leveraging EVs to people of all backgrounds and income levels. Government officials also expressed their wish to establish EVs as viable transportation alternatives that can improve efficiency and reduce GHG emissions.

Emphasis was also placed on establishing regulatory methods that can incentivize consumers to purchase EVs. Federal tax breaks as well as providing EVs access to high occupancy vehicle lanes (HOV) were two measures mentioned. Panelists agreed that growth in the number of EV users could lead to a push toward better integrating much needed EV infrastructure into transportation planning practices. This could result in a surge of infrastructure elements such as dedicated lanes for small EVs and a much more ubiquitous network of charging stations, not only in urban centers but also in inter-urban regions.

Question Summary

Panelists were asked the following questions:

- What are the difficulties associated with the adoption of EVs in California?
- How can Public-Private Partnerships (PPPs) be leveraged in the EV infrastructure development context?
- How can we better incentivize the adoption of EVs?

Panelists pointed out that the current gas tax paradigm, combined with an increase in fuel efficiency and the adoption of more sustainable EVs could result in further reduction in California tax revenue. This could limit state resources for infrastructure development projects. However, optimism was expressed since the FAST Act includes language that references research on alternative tax-generating mechanisms, such as Vehicle Miles Traveled (VMT) based taxes, which would charge highway users fees based on their total distances driven, i.e. their use of the infrastructure.

On the question of PPPs, one panelist noted that just as the deployment of the internet heavily relied on PPPs, the EV industry could foster EV infrastructure growth in similar fashion. For example, EV tech manufacturers could undertake the development of a charging station network in exchange for the right to operate it and receive compensation for its use.

On the question of incentivizing EV adoption, the general consensus was that “early adopters” interested in EVs have already purchased them, and that the federal government should incentivize future consumers through policy re-designs such as allowing EVs into HOV lanes to shorten their commute times. Also highlighted was the need to conduct research to determine the main drivers that affect EV adoption among new users.



EV Innovation Panel: The Value of New Voices in the Larger EV Discussion



Moderator:

Timothy Lipman, Co-Director, Transportation Sustainability Research Center

Timothy E. Lipman is an energy and environmental technology, economics, and policy researcher and lecturer with the University of California - Berkeley. He is also the Co-Director of the Transportation Sustainability Research Center (TSRC), under the umbrella of UC Berkeley's Institute of Transportation Studies.

Speakers:



Mark Frohnmayer, Founder and President, Arcimoto

Mark Frohnmayer's mission is to develop ultra efficient mobility solutions: vehicles, electronics, and software to catalyze the shift to a sustainable transportation system. His first product, the SRK is an ultra efficient electric commuter vehicle that strikes a balance between utility, economy and pure electric fun.



Richard Hatfield, CEO, Lightning Motors Corporation

Richard Hatfield has been involved in the research and manufacturing of two-wheeled electric vehicles for more than 6 years. Hatfield's mission has been to build EVs of this kind that have superior efficiency, performance, and affordability to current gasoline alternatives.



Vish Palekar, President and CEO, Mahindra GenZe

Vish Palekar has worked in Power, Transportation, Water Treatment and Industrial Automation, Engineering/Technology, Compliance, and Product Management. He is currently focused on launching new products to transform urban mobility in the U.S. for the young.



Ryan Popple, CEO, Proterra

Ryan Popple's vehicles replace diesel buses. They are currently deployed in a dozen U.S. cities, and have logged over 1,000,000 service miles, eliminating a quarter-million gallons of diesel consumption and reducing 4 million pounds of air pollutants.



Colin Roche, Founder and CEO, Swiftmile

Colin Roche drives revenue by selecting, training, mentoring and developing sales teams at Swiftmile to effectively hunt for new business and carve out market share. In addition, he is a team leader who balances strategy, goal-setting and motivation to fill pipelines quickly and keep them filled.

Session Summary

Composed of entrepreneurs, this panel discussion contributed and evaluated ideas around EV innovation. Panelists initially focused on various technological improvements for achieving lighter weight EVs. Some panelists commented on the use of advanced composite materials, others on lithium-battery and other future improvements that could also result in considerable weight reduction, which is a key element to increasing the range of the vehicle. Panelists also tackled a trend that has changed the transportation landscape in recent years: the advent of shared mobility providers. Some suggested devoting research to better understand a generational paradigm shift: from vehicle ownership to ridesharing and other alternative mobility options. In the spirit of larger-scale electric development, some panelists stressed that public transit has become such a popular and preferred method of transportation (especially in urban areas) that it is important to build high occupancy electric vehicles and potentially move away from single-person occupant automobiles.

Panelists also discussed innovative and alternative mobility systems, such as on-demand rideshare platforms using solar-powered eBikes. These new systems would allow the general public to more conveniently access public transportation and utilize sustainable transit options without having to endure significant delays from traffic congestion.

Question Summary

Due to the size of the panel, only two questions were asked:

- What are the effects of weather issues on EVs (particularly in the case of lighter eBikes)?
- In the case of electric buses sold to public transportation agencies, how are the manufacturers dealing with their usual capital and operational budgetary constraints on expenditures?

Given that many of the EVs proposed were two-wheeled, it makes sense to question their safety and usability in rain and snow. Panelists clarified that certain times of the year may be less favorable for two-wheel eBikes. However, these vehicles can still be part of a larger multi-modal transportation system, which ideally would be provisioned with sustainable public transit alternatives that one could resort to. Panelists further stated that this issue is still an ongoing challenge and that they are considering ways to make two-wheel EVs more robust and reliable.

In terms of “capex” and “opex” funding practices, panelists were keen to mention that electric buses are now reaching the low \$700K range in purchase price, which is competitive with diesel buses currently in use. In addition, they pointed out that battery and composite material costs have been decreasing and that the batteries can be produced and sold separately from the actual buses at a cheaper price. By doing so, manufacturers could focus specifically on producing either the vehicle itself or the battery that will be installed. This would allow agencies larger purchasing flexibility when deciding how much of each part to purchase and easier substitutions for batteries in vehicles.



EV Policies in Action: Local, State, and National Collaboration on EVS

Moderator:



Susan Graham, President's Council of Advisors on Science and Technology and Pehong Chen Distinguished Professor

Susan L. Graham's research includes programming language design and implementation, software tools, software development environments, and high-performance computing. She currently chairs the Computing Research Association's Computing Community Consortium.

Speakers:



Mark Dowd, Deputy Assistant Secretary for Research and Technology and Senior Advisor to the Secretary, U.S. Department of Transportation

Mark K. Dowd has extensive policy experience in transportation, technology, energy and environmental matters, and is leading the Department on a number of innovative initiatives including the Smart City Challenge.



Christine Harada, Federal Chief Sustainability Officer, White House Council on Environmental Quality, Office of Federal Sustainability

In this capacity, Christine Harada is responsible for promoting environmental and energy sustainability across Federal Government operations including 360,000 buildings, 650,000 vehicles, and \$445 billion annually in purchased goods and services.



Reuben Sarkar, Deputy Assistant Secretary for Transportation, U.S. Department of Energy

Reuben Sarkar oversees the Office of Energy Efficiency and Renewable Energy, which includes the Vehicle, Fuel Cell, and Bioenergy Technologies offices. In addition, he is in charge of the annual investment of more than \$600 million with a focus on reducing US oil dependency, avoiding pollution, and creating jobs by designing and manufacturing petroleum alternatives and more energy efficient cars and trucks.

Session Summary

Over the past few years, policymakers have focused on setting up a nationwide framework for EV technology development and adoption. The panelists discussed the economics of this framework. For example, at this point, EV engines are more expensive than their alternatives. Policies therefore need to be developed to bridge that gap. Panelists also agreed that boosts in EV R&D, a better understanding of consumer behavior in the EV market, and the development of new smart mobility options leveraging EVs could lead to a faster adoption of EV technology.

Panelists also delved into other applications that could further benefit society, such as the development of smart cities, where larger EV fleets play an essential role in satisfying citizens' mobility needs. To make these applications possible, panelists called for closer collaboration between US DOT and DOE. This collaboration could also stimulate the growth of the EV market through investments in experimental projects leading to further innovation.

Some panelists examined the future of EVs by discussing how the market may expand. They ultimately stressed that the West Coast states have larger EV adoption rates and that it is imperative to bring other states with different cultures (i.e. general attitudes towards EVs) into this trend. To do so, it is necessary to find mechanisms that incentivize the adoption of EVs and other sustainable modes, and to educate the public on the positive aspects of alternative transport modes.

[Question Summary](#)

Panelists were asked the following questions:

- What are ways to include parts of the population that have thus far been unable to participate in EV systems?
- How can we help a larger part of the American population gain consistent access to EVs?
- How do you foresee EV infrastructure development taking place in the future?
- What are avenues to overcome EV funding difficulties in cities that don't have access to enough resources to help implement the technology?
- How can we leverage policies within the public sector to increase the use of EVs in public transit?

The critical pieces when approaching wider inclusion of the population, as stated by the panelists, should be opportunities and collaboration. Panelists emphasized that if cities want to succeed in providing the public with wider access to EVs and get policy-makers fully engaged in this process, focus must be on equity, particularly among those who do not have access to cars. In addition, specific mechanisms must be found provide communities access to these resources.

Helping the larger public gain access to EVs is not an easy task but panelists reflected on US DOE policies being developed that would help in this regard. The panelists who commented on these efforts revealed that the US DOE is testing new analytical models that can help assess and predict different technology investments, in order to estimate the outcomes of proposed EV policies.

With regard to infrastructure development, there was a general concern that investments such as charging stations could potentially go to waste in the long term, due to possible technological obsolescence. However, panelists explained that the EV transition has to happen gradually. They also mentioned that public and private manufacturers would not issue products or services that were not necessities for EVs. To make these products and services more relevant, panelists suggested using policies and regulations to drive new EV services forward (e.g. establishing EV adoption mandates, providing financial incentives to acquire EVs, etc.)

Funding difficulties have also been an obstacle for cities that wish to use EVs but cannot afford to do so. In light of this, panelists highlighted programs from the DOT that give technical assistance to cities, Oakland, CA being a case in point. The panelists assured that any city interested in such development should be able to look to the government for support and also provided the recent Smart City Challenge was cited as an example of the commitment that the Federal government has towards the development of alternative innovative mobility.

For people who are unable to drive, concerns also arose regarding the implementation of a wider range of public transit-oriented developments. Panelists foresee a future in which cities could work together to achieve a better public transportation system and where the Smart City Challenge will provide a testing grounds for startups to address this mobility equity problem.



EV Technologies: New Developments and Concepts

Moderator



Scott Moura, Assistant Professor, Civil and Environmental Engineering, UC Berkeley

Scott Moura's research interests include optimal and adaptive control, PDE control, energy storage, distributed energy resources, vehicle-grid integration, and batteries.

Speakers



Said Al-Hallaj, Chairman and CEO, All Cell Technologies LLC

Said Al-Hallaj's efforts have led to the formation of two startup companies at IIT: All Cell Technologies, to commercialize lithium-ion batteries for portable and transportation applications, and Sun Phocus Technologies, to commercialize a hologram plan concentrator (HPC) technology in building the integrated photovoltaic (BIPV) market.



Justin Fishkin, Chief Strategy Officer, Local Motors

Justin marries a lifelong dedication to sustainability and making a difference in the world with a background in finance and investing. In his spare time, Justin founded The Holster Project, co-founded digital indie record label Holster Records, serves on the Board of Street Soccer USA, and remains a Senior Advisor to Carbon War Room.



Jonathan Weinert, Sales and Marketing Manager, Robert Bosch LLC

Jonathan Weinert's primary goal is to turn cutting-edge clean transportation technologies into mainstream profitable products. He has set out to accomplish this by focusing on electric motors and eMobility products, especially electric scooters and electric vehicles, batteries, hydrogen, and biofuels. In addition, Weinert is a published expert on the Chinese electric bike and scooter market and technology.

Session Summary

The discussion in this panel centered on recent innovative developments that further advance electric vehicles technologies, including: 3D-printed cars that flexibly provide customers with options based on their preferences; an interconnected system of lighter batteries where certain ones cool off while others power the car in an optimal fashion to extend the overall system life; and new developments, as well as recent commercial trends, in pedal-assisted eBikes.

Panelists discussed a platform developed by Local Motors that uses a crowd-engineering/design approach and rigorous prototype testing to create 3D-printed cars. By using co-creation and open-sourcing ideas generated from the public, this platform can be optimized to cater to all types of consumers. In addition, micro-factories are being opened to the public, to

give consumers the power to build their own prototypes and learn about an alternative manufacture process.

Panelists also covered a new battery layout proposed by All Cell Technologies that is lightweight, long lasting, and affordable. The main innovation is that the batteries are arranged in a way that allows certain battery cells to cool off after long periods of use while others continue to power the vehicle. By doing so, this battery system is able to significantly increase an EV's longevity, mobility, and efficiency.

Panelists also showed projections that revealed that vehicles with smaller batteries are expected to gain acceptance faster than EVs with larger battery demands. For example, pedal-assist electric bikes have recently been gaining momentum in European countries and some expect the trend to transition soon to the US. The reason behind this lag is due to the relative level of bike-oriented infrastructure development between Europe and the US. In numerous areas of the US, people still do not feel safe riding bikes or eBikes. To fix this problem, it is important to view eBikes not only as a recreational vehicle, but also as a commuting tool. Caltrans projections have shown that eBike usage could triple by 2020 and that widening bike lanes and protecting them from other vehicular traffic could foster wider public adoption.

Question Summary

Panelists in this session were asked the following questions:

- What are the standard costs of EVs that are locally manufactured using the Local Motors model for consumers?
- What can be said about the the lower speeds of smaller EVs,?
- How can we increase the value of small EVs for the public to match the utility of the automobile?
- What are future developments for EVs beyond lithium-ion batteries?
- How do small EV manufacturers evaluate business performance and how are they trying to capture new customers?

For consumers who want to manufacture their own electric vehicles, panelists speculated that low-end EVs would cost around \$10-12K while higher-quality EVs would cost around \$60-70K, based on needs and preferences. In addition, panelists also put forth the idea of partnering with the public sector to subsidize production costs in exchange for usage of the data that these vehicles could generate. The data could be used for various purposes, such as cataloguing the state of roads and highways.

While it is true that smaller EVs may on average be slower than gas-reliant automobiles on highways, panelists argued that speeds on non-highway roads could range up to 40 mph while maintaining high efficiency, which makes eBikes and other small EVs a great alternative in congested areas.

With regard to increasing EV value for customers, panelists stated that the easiest way to increase adoption is to let people try the technology. They emphasized patience until the public becomes accustomed to these new vehicles, while paying close attention to acquisition trends, as keys to understanding the EVs' value to the public.

Lithium-ion batteries are already changing the automobile industry for the better, but panelists claimed that they expect battery sizes and types (beyond lithium-ion) to vary over the next ten years to accommodate different types of new EVs.

Traditional business performance metrics are particularly difficult to meet in this sector, and panelists explained that factors such as partnerships and scalable business models are key to meeting their desired goals. They argued that by creating a product that people really want to try and by developing manufacturing practices that allow some of these companies to almost have no inventory and produce products on-demand, businesses would be able to meet their quotas and continue to grow significantly.



New Opportunities to Scale EVS: Business Models, Shared - Use Systems, and Non-Traditional EV Markets

Moderator



Susan Shaheen, Adjunct Professor and Co-Director, Transportation Sustainability Research Center, UC Berkeley

Susan Shaheen is an internationally recognized leader in innovative mobility research. Susan continues to focus on carsharing, as well as several other areas, including: bikesharing, and ridesharing; ecodriving for private vehicles and freight; smart parking management for transit and trucks, fuel cell, electric, and plug-in hybrid vehicles and infrastructure.

Speakers



Jed Ela, Sustainability Advisor, U.S. General Services Administration

Jed Ela oversees the GSA's sustainable supply chain efforts and environmental sustainability program, including the agency's sustainability plan and projects for reducing energy, water, waste, and greenhouse gases.



Jay Friedland, Vice President of Strategy and Sustainability, Zero Motorcycles Inc. and Senior Policy Advisor for Plug In America

As the Legislative Director at Plug-In America, Jay Friedland is working to accelerate the adoption of plug-in electric vehicles powered by clean, affordable, domestic electricity to reduce our nation's dependence on petroleum and improve the local and global environment.



Michael Keating, Founder and CEO, Scoot Networks

Michael is a strategist, designer, and environmentalist who founded Scoot to bring fast, affordable, electric transportation to cities everywhere. Prior to founding Scoot, Michael built a successful open source transportation software business at OpenPlans, and was a management consultant with GreenOrder and The Boston Consulting Group.



Mark McCall, Executive Director of the Loan Programs Office, U.S. Department of Energy

Mark A. McCall was appointed by President Obama in July 2015 to serve as Executive Director of the Loan Programs Office (LPO). Mr. McCall oversees the program's more than \$30 billion portfolio of loans and loan guarantees, making it the largest project finance organization in the U.S. government.



Roland Hwang, Director of Energy and Transportation Program, Natural Resources Defense Council

Roland Hwang works at the state and national levels to maximize energy efficiency in vehicles. A noted expert on alternative fuels, he has played an instrumental role in the creation and adoption of California and federal fuel standards.

Session Summary

Participants in this panel discussed ways to better promote EVs to the general public including: creating on-demand mobility systems for electric bikes and scooters in urban areas; exploring untapped markets for electric vehicles, providing better leasing options to transportation agency customers; and expanding the ZEV market to lower income communities.

The panelists discussed the case of Scoot Networks, an affordable on-demand electric mobility option that uses electric scooters to provide an every-day mobility option. This platform offers a fleet of scooters and bikes for public use in San Francisco, which matches well with young non-car-dependent citizens who need transportation across the city. The company's analysis revealed tremendous efficiency numbers when compared with traditional mobility options such as a regular fuel-engine automobile.

Additionally, panelists discussed opportunities to reach out to markets beyond the traditional consumer market for vehicles, such as police and public safety vehicle fleets. Panelists revealed that in one of these cases, the lack of noise of electric vehicles offers multiple benefits for patrolling. Some panelists expressed a belief that spreading this kind of program globally would allow the public to greatly benefit from better safety.

Alternative pricing options for lower income communities were also discussed at length in this final panel. Two pilot project programs that promote electric vehicles in lower income communities were discussed. The first focuses on Enhancing Fleet Modernization, which allows low income households to purchase cleaner-engine vehicles or a transit voucher. The program provides lower-income families with purchasing resources on par with those of middle-class families to gain access to more sustainable transport.

The second pilot project is a low-income financing program instituted at the community level, e.g. neighborhoods. Testing the program in smaller areas helped researchers discern its viability on a larger scale, and with a wider audience. The two programs focus on working with lower-income communities to create solutions that meet their needs and guarantees access to technologies that residents could not otherwise afford.

Regarding financing, panelists highlighted that the Department of Energy (DOE) has set up a Loan Finance Program that provides opportunities for EV technology development by supporting technologies that focus on alternative fuel vehicles. Through this program, Tesla and

Nissan Leaf Manufacturing were able to scale their innovative technologies. The DOE hopes to sponsor other innovative companies in the future.

Question Summary

Panelists were asked the following questions:

- How significant are large purchases of EVs by the government?
- How can new opportunities be created for startup companies in the EV market?
- Is there value in short-term EV exposure within a shared mobility setting?
- Are Light Electric Vehicles (LEVs) qualified for ATVM financing?
- What are some of the dangers of more lightweight vehicles entering the market?

With regard to large purchases of EVs, panelists assured the audience that bulk orders are fairly common and range in magnitude depending on the governmental organization issuing the order. Panelists also stated that large-scale orders bring significant benefits to both the private and public sectors. The private sector benefits from a major bump in their revenues while the public sector can leverage their size to obtain bulk discounts and purchase efficient vehicles at lower prices. The point was raised that one possible path to create new opportunities both for startup companies, as well as established players in the industry, comes from the Advanced Technology Vehicles Manufacturing (ATVM) financing program, which is managed by the DOE. The program issues sizeable loans to help eligible manufacturers develop advanced technology vehicles and associated components in the U.S. Short-term EV exposure to small EVs through the use of shared mobility systems is important since it provides a mechanism for consumers to test and become acquainted with the technology. Panelists shared multiple accounts of instances in which users of eBikes and electric scooters decided to purchase a small EV after being exposed to them through shared mobility providers. Therefore, short-term exposure to small EVs should be seen as a source of significant value for EV manufacturers.

One of the panelists explained that ATVM financing is currently limited to light-duty passenger vehicles only. This limitation excludes two-wheel LEVs at the moment. However, the panelist also expressed optimism that this limitation will eventually be relaxed to include other EV types such as two-wheeled and medium/heavy-duty vehicles.

The panelists capped off their discussion by addressing the potential dangers of introducing more lightweight vehicles in the streets. They emphasized the point that generally fatalities occur when a heavier vehicle collides with a lighter one and thus argued emphasis should be placed on reducing the overall weight of the vehicle fleets that currently use our streets and highways. In addition, panelists warned about the importance of adapting highway and street regulations to accommodate safer conditions for LEVs.

Event Summation - by Professor Emerita Elizabeth Deakin



Elizabeth Deakin, Professor Emerita, City and Regional Planning and Urban Design, UC Berkeley

Elizabeth Deakin is Professor Emerita of City and Regional Planning at UC Berkeley, where she also is an affiliated faculty member of the Energy and Resources Group and the Master of Urban Design group. Deakin's research focuses on transportation and land use policy and the environmental impacts of transportation.

Background

Some of the earliest automobiles were electric. They were pushed off the market early in the 20th century by vehicles running on gasoline and diesel fuel, power systems that made it feasible to travel long distances at high speeds. In the 1970s and 80s oil embargoes and oil cartels spurred renewed interest in EVs, but the EVs of that era still lacked range and power and did not attract much consumer interest. Today's EVs are greatly improved, but still face challenges concerning range and power. So why is there a push for EVs now?

One reason that EVs are back on the agenda is the concern about climate change. This is in addition to long-standing concerns about the adverse impacts of current transportation systems, such as congestion, safety hazards, and emissions hazards. California has legislative mandates to reduce greenhouse gases and low emissions vehicles are an important part of the state programs. Federal programs also support emissions reduction and the federal government has is sponsoring research, development and testing of new transportation technologies, systems and innovative services, including EVs. The drive towards sustainability has been increased interest in such innovations, as have smart city challenges, which offer opportunities to think about transportation anew.

Advances in technology have been an important factor in putting EVs back on the agenda, in particular the substantial improvements in batteries that have occurred over the past several decades. Innovations in materials and systems engineering also have made EVs work far better than they did two decades ago. Many of the electric vehicles being produced today are ones that mainstream consumers, and not just advocates and enthusiasts, would want to use, and that's been really important in bringing EVs back into the policy discussion in a major way.

Other supply-side pushes result from an emergence of entrepreneurial interest in transportation applications from the dot-com industry, the people who've developed software, sensors and new manufacturing processes like 3D printing. These innovators are creating new ways of putting transport products together and operating them. There's also been innovation in soft technologies that create networks of users that can share vehicles and rides. The entrepreneurs who have come up with these new products and processes are out there looking for markets and trying different things. There will be some stubbed toes and some flat-out fall-

on-your-face failures, but that's okay because there are also some successes coming along and we'll see things that actually work in the market that will take off. EVs fit well with the innovators' overall emphasis on radically improved transportation systems.

Supporting that is the demand pull is coming from new lifestyles and life cycles – in particular, urban dwellers who are just not interested in moving to the suburbs, and aging baby boomers who recognize that they are going to need a little help with their transportation in the coming years.

Young people are taking their time forming their own households, and when they do, many of them rent city apartments. They are not rushing to buy a house in the suburbs. Whether this is an effect of a shaky economy or a permanent change in values remains to be seen, but even if it is a transitional phase it is one that is creating a sizeable market for urban transport alternatives ranging from better walking and biking options to carsharing.

In this group are people who don't want to buy a new car because it seems too expensive for the amount of use they'll get from it. They also don't want to buy an old clunker that they can't be sure of. They don't need a car on a daily basis, though they might like to have a car available now and then. That's a lot of my students. They tell me, "I don't want to spend \$30,000 to \$40,000 to have something that's gonna sit in my driveway most of the time, because I walk or bike when I can. And I don't want to spend \$10,000 on something that's gonna break down on the freeway and put my life at risk." These are people for whom the new vehicle sharing options are well-matched.

At the same time we're experiencing an aging population. People like me, baby boomers, are getting to retirement age, and for many of us, age is beginning to dull our vision and take away some of the flexibility of our necks and shoulders. Driving is going to become a little more difficult. We all grew up driving, and increasingly we are scared that we could end up unable to drive, because for many of us that would mean that we can't stay in our homes. If we don't have the ability to drive any more, we won't have access to the grocery store or the doctor or our children and our friends. That's a strong motivation to think about new technologies, in particular automated vehicles.

There's also a bunch of people we didn't hear very much about today. One big group are people who don't have driver licenses. We don't let them drive. They're just kids! It's possible that new vehicle technologies could open up mobility freedoms for people at the young end of the age spectrum as well as the old end of the age spectrum.

Then there are people who can't afford a car, but need one, because they have to have a car to get to work and take care of their household. They'd prefer to buy a reliable used car but they end up with a \$2000 clunker that is not very reliable and not very safe. Finding a way to make a safe, reliable vehicle available to them would be good for them and good for us as a society.

And finally, there are the people who want a car and will drive it a lot, but also want to be green. Some on this group will be looking for an EV. Others will like the idea that they can buy a membership that will let them have the use of a car when they need it, but can let other people use it when they don't - seeing sharing a vehicle as an action that will let them do something that's good for society and good for the environment and for the community.

All these situations and individual motivations are creating demand pull for new technologies.

Cities are amplifying this demand pull by looking for additional and more creative ways of dealing with long-standing problems such as congestion, pollution, and parking, and newer concerns such as resiliency in the face of global warming. They are looking for transport solutions that will make the city more efficient and cost-effective while providing a high quality of life for residents and supporting thriving commercial districts. Fast, safe, efficient transportation for them means well utilized transport systems, transit or cars – getting a lot of mobility for the number of vehicles on the road and the amount of urban land consumed.

Key Themes from the Presentations

Let me turn now to some key themes from the presentations. One thing that kept coming up was there are a lot of specialized markets, large and small, for electric vehicles, and a lot of different vehicle types that can be matched to those markets. New manufacturing processes open up possibilities for even better matching of vehicles, technologies, and markets. That raises the question of whether there should be an EV for every market, not just sedans and small personal vehicles but also electric SUVs and perhaps electric pickup trucks. The question here is whether designers should be matching vehicle performance to serve “most” travel patterns (that is, urban travel, relatively short trips with only a few people in the vehicle) vs. trying to build a vehicle or set of vehicles that can replace existing ones in all respects including carrying capacity and range. And on the range issue, there is the question of whether the vehicle needs to have the range or it can be provided by roadside infrastructure, for example, by installing electric charging facilities on the interstates.

Quite a bit of the discussion was about vehicles that are fun, which is certainly a positive thing. However, I think we need to have more women in the room discussing this because a lot of those people who are having fun seem to be guys. If you’re interested in large markets, you have to consider what women would think about the vehicles, the features they need and want. You may have kids in the vehicle, for example, along with groceries and a briefcase. Thinking about women’s interest in EVs is something that needs more attention.

We’ve heard that the electric vehicles can be buses as well as personal vehicles. Especially if this is combined with automation, it could transform transit services, for example by allowing services to be provided in thin markets at an affordable cost and minimal environmental impact.

Ten Items for Further Study

To conclude, I would like to list the 10 things we didn’t hear very much about, all of which deserve further study.

1) **Market barriers:** We mentioned price issues; if you have to be rich to own an EV or an automated vehicle, that’s a market barrier. Weather could be an issue for some of the

vehicles we heard about - there's a question of whether it is going to work in snowy New Hampshire or in California in January when that cold rain is pouring down. We need to have more discussion about who and how many would pay a premium for vehicles with limited performance, or whether we need a price point that's much lower. Another possibility is that many EVs could be second or third vehicles used for special purposes, much the way that some households have boats or jet skis or all-terrain vehicles.

2) **Infrastructure:** We need more discussion about the infrastructure that new transportation technologies might require. We heard a little about charging stations, but if we get automation on some vehicles and not others, will we need separate lanes? If so, which of the vehicles would need their own lane? At the extreme I can imagine roads that will look like rainbows, with lanes painted different colors for different kinds of vehicles. It's not necessarily a matter of separating the Escalade from the mini EV, it's also the garbage truck and the dump truck and the semi that's delivering to the grocery store we that have to think about. And it's not just transportation infrastructure; we have some very serious issues about where we are going to get the electric power to support a whole fleet of EVs. What fuels will produce the electricity and what are the environmental consequences of those choices? We have some serious issues about electricity transmission systems problems to go along with that.

3) **Financing:** Going along with the infrastructure questions are questions about how to pay for transport infrastructure, an issue that is already arising with increasingly fuel-efficient vehicles of all types, and the federal highway trust fund bankrupt or very close to it. Just as infrastructure issues aren't limited to streets and highways, neither financing issues; if demand for electric power surges with the growth of EVs new strategies to pay for electric power infrastructure will likely be needed.

4) **Automation:** Some cities are already thinking about automated vehicles as a way to make transit and paratransit work better, to handle urban goods deliveries, and perhaps to handle curbside refuse and recycling collection. But we'll have to have a bigger discussion of this. For one thing, there could be very serious labor repercussions from some of the moves being contemplated.

5) **Regulatory issues:** Regulatory issues will come up with as EVs make use of new materials, present new vehicle designs, and offer different operating capabilities. Infrastructure design standards will raise regulatory issues as well. Safety and emissions rules will need to be established. Licensing and taxation issues also will arise. The questions will be the extent to which existing rules are adequate or should be modified, or new rules will have to be formulated. We are seeing some of this now with the emergence of ride-matching services and the debates over whether they should be regulated as taxis or as something different.

6) **Transitions:** More investigation is needed into the ways that the vehicle fleet might transition to EVs and automation. This includes questions about how fast the turnover in the vehicle fleet will be. Currently it takes something like 15 years for the personal vehicle fleet to turn over, so even if all new cars were equipped with particular technologies by a certain

date, we can expect a long period when we have a mix of vehicle technologies on the road. If only some vehicles offer the new technologies, or if the technologies are high priced options initially, it will take even longer for the innovation to diffuse. Of course, it is possible that regulations or incentives could result in a faster automotive transition. These are issues worth studying – looking into alternative implementation pathways and their implications for market penetration.

7) **Early adopters:** There is a tendency to look to early adopters to investigate potential markets, but I would recommend caution here. Early adopters are often enthusiasts and their behavior may not be at all like that of the mass market that needs to accept the product if it is going to fill more than a market niche. For example, it was suggested that we could learn about EV markets by looking at ho's buying e-bikes and how they're using them. Maybe we can, but maybe E-bike purchasers are not very representative of the larger population. The problem with trying to do research on consumer reactions to proposed new technologies is that its potential users aren't familiar with those new technologies. Researchers draw analogies from other experiences and create scenarios `can help attain some insights, but also have limitations, notably the difficulty in communicating a realistic understanding of what the real-world, day-to-day operating conditions for the new technology would be like. In addition, when studies are conducted by advocates for the technologies, they often are marred by optimism bias, stressing benefits and downplaying problems and the sheer inertia of the existing system.

8) **Serving the whole population:** There has been some attention recently to getting EVs and other innovative transportation systems such as carsharing into low income communities. That's important, but there are a lot of middle-income communities who also think about what these new vehicles would cost and could be put off by how much money they'd have to spend on them, so that's an issue too. Also, are we designing these vehicles so that they will be usable by people who have vision disabilities, who have mobility disabilities, who have mental or emotional disabilities? As noted earlier, the elderly are often beset with physical decline that makes driving difficult, but there are plenty of younger people who also are mobility impaired. At the Shanghai Exhibition a few years ago, General Motors presented their vision of a car of the future that could serve this population, combining automation and electric power in a small, affordable, flexible vehicle designed to operate on a separate guideway, at least for starts. We can imagine such a vehicle that would greatly expand the mobility of populations that might not now be able to drive safely. This could extend to kids, who are a big share of the population and today are heavily dependent on adults for their transportation.

9) **Freight applications:** If buses can be electric, why not delivery vehicles? Could we have urban freight being delivered by electric vehicles? Is there a possibility for other urban service vehicles to be replaced by EVs, e.g., garbage trucks? Are there scenarios in which long distance freight trucking could be electric?

10) **Labor impacts:** The labor impacts of electrification of a portion of the vehicle fleet, along with other technology advances, have already been significant; automation could

result in even greater changes. New technologies for the vehicle create not only demand for new products but also demand new skills for designers, construction and maintenance workers, regulators and inspectors. Automated pickup and delivery services, automated taxis, transit and paratransit, automated intercity trucking. All of these are changes that could have significant impacts on the number of jobs available in the transportation sector. Labor impacts could pose challenges to technological change unless they are dealt with creatively and sensitively.