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The conference was co-chaired by John DeCicco, associate director and research professor at UMEI, and Tom Lyon, professor of sustainable science, technology and commerce at U-M’s Ross School of Business and School for Environment and Sustainability. Special words of thanks are due to Ellen Hughes-Cromwick, now at Third Way, for her key role in guiding TE³ and helping develop the program through the main planning stages of the 2019 event when she served as UMEI’s associate director for economics and policy.

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WE WISH TO THANK

The Erb Institute and Ross School of Business for their support of travel scholarships for out-of-town students that enabled us to enhance the diversity, equity and inclusiveness of participation in the event.
The University of Michigan’s Conference on Transportation, Economics, Energy and the Environment (TE3) brings economists and other academic researchers together with practitioners from industry, government and the public policy community to share knowledge, exchange ideas and strengthen the collective ability to address the transportation sector’s energy and environmental challenges. Hosted by the University of Michigan Energy Institute, the sixth annual TE3 event was held in Rackham Amphitheatre on October 18, 2019, with over 200 people attending.

The 2019 conference focused on the electrification of mobility worldwide. Technology advances along with falling costs for energy storage and renewable energy are poised to accelerate a transition to electric vehicles (EVs), away from the petroleum-fueled, internal-combustion engine cars, trucks, vans, buses and two-wheelers that have dominated personal mobility and goods movement for over a century. TE3 participants explored the challenges and solutions surrounding this transition with sessions addressing consumer interest in EVs, vehicle charging, the role of a cleaner electric grid, the economics of EVs and the interactions among different policies. The conference closed with a high-level panel discussion about the tensions that confront electrification-related policy development in the world’s leading vehicle markets, highlighting developments in the United States and China.
Program

FRIDAY, OCTOBER 18, 2019

Rackham Amphitheatre, 915 East Washington Street, 4th Floor
University of Michigan, Ann Arbor

CONVENE AND WELCOME

Anna Stefanopoulou
University of Michigan Energy Institute

VEHICLE ELECTRIFICATION WITHOUT TRADING CARBON FOR CARBON

Howard Learner
Environmental Law & Policy Center

Session One

ENTICING EV CONSUMERS: BUYER INTENTIONS AND CHARGING CONSIDERATIONS

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ChargePoint

Discussant: Alex Keros
General Motors

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Patricia Monahan
California Energy Commission
Julia Rege
Global Automakers
Dan Levy
Credit Suisse
The sixth-annual University of Michigan Conference on Transportation, Economics, Energy and the Environment (TE³) brought together experts in these fields to discuss the growing global adoption of electric vehicles (EVs).

An invitation-only conference held each fall, TE³ is hosted by the University of Michigan Energy Institute (UMEI). Over 200 people attended the one-day event in U-M’s Rackham Amphitheatre on Friday, October 18, 2019, drawing individuals from the automotive, energy and related businesses, government agencies, national laboratories and nonprofit organizations as well as academic researchers and students.
The conference was segmented into four sessions covering consumer intentions and charging considerations, the economics of EVs, policy interactions and global policy challenges. The first three sessions were structured around peer-reviewed research and included panelists who summarized insights from their papers, along with session chairs and discussants who offered complementary insights as practitioners in the field. The final session was a high-level panel discussion that addressed the issues confronting policymakers who hope to accelerate the transition to electrified transportation worldwide.

The conference was brought to order by TE³ co-chair John DeCicco, an associate director and research professor at UMEI. He then turned the podium over to Anna Stefanopoulou, the director of UMEI and William Clay Ford Professor of Manufacturing, who welcomed the participants with opening remarks. After her remarks, Stefanopoulou introduced Howard Learner, executive director of the Chicago-based Environmental Law and Policy Center, who delivered a talk on “Vehicle Electrification Without Trading Carbon for Carbon.”

THE NEED FOR CROSS-SECTOR POLICY COORDINATION

Learner reminded the audience that in certain parts of the United States—in portions of the midwest and mountain states, for example—most electricity is still generated using fossil resources, including coal. In such regions, charging an EV could lead to an increase in power sector carbon dioxide (CO₂) emissions that exceeds the decrease in emissions as the EV replaces a gasoline vehicle in the transportation sector.

“If we are developing an EV charging system and accelerating the market penetration of electric cars, and half of the charging is coming from power supplied by fossil fuel, then we are not cleaning up the system when it comes to climate change,” said Learner.

North Dakota is a “carbon-for-carbon” state he said, with a power mix that is 70 percent fossil (mostly coal) and just under 30 percent wind power. A pro-coal lobbying group, the Lignite Energy Council (based in Bismarck, North Dakota’s capital) is very interested in increasing EV adoption. “From the perspective of the Lignite Energy Council, it’s smart if you can drive up EV demand, then you can sell more coal,” Learner said.

Midwestern states can avoid trading carbon for carbon by tapping into the region’s surplus of wind and nuclear power. The midwest has negative pricing in many hours of the evening because there is so much wind and nuclear running. Because of this situation, some utility companies support EV adoption and advocate night-time charging. For example, several school districts in Illinois are being encouraged to switch from diesel to electric
school buses. Because school buses are normally on the road during the day during the academic year, it would allow for charging in the evening, using wind and nuclear, said Learner. He recommended that the public and private sectors develop integrated policy strategies, technologies and business approaches to avoid the trading-carbon-for-carbon trap.

Session One

WHAT DO EV CONSUMERS NEED? WHAT DO THEY WANT?

Following Learner’s talk, the first technical session of the conference took a deep dive into charging considerations and consumers intentions. It was chaired by Anne Smart, vice president of public policy at ChargePoint, a California-based company that provides more than 100,000 EV charging stations globally.

Smart said the need for fast charging can’t be overstated given the future growth of EV ownership. She cited a Bloomberg report projecting that by 2040, 60 million electric vehicles will be sold, capturing 55 percent of the global light-duty vehicle market. Meeting that demand will require addressing the hurdles to EV adoption such as charging accessibility, charging speed and vehicle range.

There are three types of charging stations, explained Smart: Level 1, Level 2 and DC fast charging. Level 1 charging is basically plugging into a 110-volt wall outlet, like that used for ordinary home appliances. With Level 1 charging, “it can take many hours or even a day to fully charge an all-electric vehicle,” Smart noted. A Level 2 charging station is what ChargePoint makes for workplaces and around town. Its 220-volt outlet is similar to that used for an electric clothes dryer. “You can buy home charging stations on Amazon that are Level 2,” noted Smart, “which take up to four hours to fully charge a car.” With DC fast charging and the new EVs that can handle it, Smart said that charging time is cut down to 15–45 minutes. However, she acknowledged the concerns that fast charging could reduce the life of EV batteries.

Smart then introduced Alex Keros of General Motors (GM). He noted that installing an at-home, Level-2 charging station can be daunting to the average EV owner. The consumer must figure out rates, find an electrician, get quotes and pay for the equipment and installation. “Think about how complicated this is,” said Keros. GM, which makes models such as the Chevy Bolt EV, is working to make installing home charging stations less cumbersome. He described GM’s partnership with Qmerit, which offers EV-customers access to a nationwide network of installers for at-home Level 2 EV charging stations.

Keros said one remedy for the inconvenience associated with installing an at-home charging station is to basically avoid
“If you put in 10 charging stations at work, 20 cars show up. You put in another 10, and 40 cars show up. Suddenly you have a problem on your hands, and such a problem is what sells cars.”

— ALEX KEROS, General Motors

it altogether. “Workplace charging does everything from helping to solve duck curve problems, all the way to retaining talent and building a good image overall for EVs,” he said. For example, GM has 927 workplace charging stations at 57 North American sites.

Easy access to charging, Keros said, could encourage EV adoption. “If you put in 10 charging stations at work, 20 cars show up. You put in another 10, and 40 cars show up. Suddenly you have a problem on your hands, and such a problem is what sells cars.”

THE GAINS AND PAINS OF CHARGING UP

The first researcher on the panel was Matteo Muratori, a senior engineer at the National Renewable Energy Laboratory (NREL). He provided insights from a study he and his colleagues had conducted together with David Greene from the University of Tennessee, Knoxville, to estimate the value of public charging infrastructure.

“For the non-economist,” Muratori explained, “the tangible value of DC fast charging increases as charging availability increases. If I have more charging stations, I am willing to pay more. The value for me is higher.” Their research found that, for
purchasers of a new battery electric vehicle (BEV) with 100-mile range and home recharging, existing public fast chargers were worth about $1,500 for intra-regional travel, and fast chargers along intercity routes are valued at over $6,500. Fast charging infrastructure “is a very important aspect to the overall economics of buying an electric vehicle,” said Muratori.

Next up was Eleftheria (Ria) Kontou, whose research with Muratori and other NREL colleagues analyzed electricity rates for EV DC fast-charging in the United States. She noted that a dense network of fast-charging stations can support the operation and adoption of electric vehicles by eliminating range anxiety, enabling both short- and long-distance travel. However, Kontou noted, existing electric utility rate structures might hit EV owners with high costs when they use public charging stations. “Steep utility fees are killing electric-car charging stations” read one of the headlines she displayed when introducing their analysis.

Kontou explained how electricity bills contain both energy charges and demand charges. The former are based on how much electricity is consumed (in kilowatt hours). Demand charges are based on the peak power draw (in kilowatts) at various times of day and can result in very high costs if fast charging stations experience low utilization levels. Their analysis of rate structures offered a number of insights. Charging stations with low utilization see the highest average electricity costs as well as the largest variability in costs. “Costs can be reduced when stations are used by more drivers,” she noted, or when “drivers consume greater electricity volume per charging event.” Kontou concluded by highlighting how appropriate rate-making can reduce EV consumers’ public charging costs, pointing out that rates with only energy charges are best during the early stages of a transition to electric vehicles.

Other countries are much farther along in EV adoption than the United States, and the most significant such market is China’s. Yi Wen of the University of Tennessee, Knoxville, provided an overview of EV developments in China, highlighting a number of key differences between the U.S. and Chinese situations. He noted that China has sold more than 2.5 million EVs since 2003. “If we look at last year’s data, China sells close to half of all the EVs in the world,” said Wen.

He emphasized how government policies have driven the adoption of New Energy Vehicles (as electrified cars are termed in China), in keeping with the country’s commitment to reduce the carbon intensity of its GDP by up to 55 percent within ten years. Wen detailed some ways that the U.S. and China situations differ, including how Level 2 charging is standard because the country uses 220 volt outlets; that many Chinese consumers are already familiar with electric bikes; and EV owners get exemptions from the otherwise highly restrictive license plate and traffic zone controls.
“How can we make sure that EV-friendly policies are switching drivers from regular vehicles to EVs, but not non-drivers from other modes to driving?”

— YI WEN, University of Tennessee, Knoxville

Wen and his colleagues conducted a survey of over 1,200 people in Beijing, which enabled them to identify positive and negative factors influencing EV purchase consideration. He also placed electrification in the context of broader sustainability goals, asking “How can we make sure that EV-friendly policies are switching drivers from regular vehicles to EVs, but not non-drivers from other modes to driving.” Wen noted that mini-EVs and EV car sharing may be ways to benefit from electrification while reducing the impacts of vehicles overall.

Anne Smart moderated a brief panel discussion and then opened the floor for questions from the audience. One person asked if public charging stations are necessary in the U.S. and Canada, since most charging occurs at home or work. “Absolutely,” said Keros of GM, noting that for consumers who lack access to home charging, “this is going to be absolutely critical.”

Muratori noted that increasing the number of fast-charging stations reduces range anxiety by providing a sense of security. “If there is an emergency, you can jump in your car and drive wherever you have to go with no problems,” he said. “The only way to do that is to provide a network of public charging stations that consumers can rely on and trust.”

Another audience member raised concerns about long lines and wait times at charging stations. Smart replied that, “setting a price for charging, including idle time, is important and a good way to make sure drivers are moving vehicles when they are fully charged.” She gave the example of Target, a ChargePoint customer, which offers one hour of free charging and then charges $2 an hour after.

Smart asked the panel how the availability of EV models and consumer choices might impact EV adoption. Panelists agreed that it’s not just the total number of EV models available, but rather that EVs are available to compete with the most popular gasoline vehicles, as well as their affordability, that are critical. Muratori suggested that “EV makers need to start thinking about what the majority is purchasing,” noting high sales levels of SUVs and pickup trucks. He said that having electric options available in the SUV and pickup segments of the market “could be a game changer for the EV market.”
Session Two

MONEY MATTERS: EV ECONOMICS

After a short break, the conference turned to the economics of EVs and their environmental impacts. Sharyn Lie, of the U.S. Environmental Protection Agency’s Office of Transportation and Air Quality, served as session chair.

Benjamin Leard, of Resources for the Future (RFF), offered up wisdom from an analysis of what vehicles consumers would have purchased had they not bought EVs. By way of example he explained how, compared to replacing a sedan with a Tesla, “the savings are much larger if a Tesla is replacing a Ford F-150.” The analysis by Leard and his colleagues found that EVs replace vehicles that are relatively fuel efficient, averaging 4.2 miles per gallon higher than the overall new light duty fleet average.

In reference to the U.S. federal tax income credit of $7,500, Leard said the credit has increased EV sales by 29 percent, but that the subsidy was regressive because it benefits higher income households more than lower income households. He said that varying the subsidy by household income is something to consider.

GREENER GRID = GREENER EVS

Despite the costs of EV ownership, most consumers can take comfort in the fact that they’re better for the environment. While that’s not always true, it’s become increasingly more so, according to Stephen Holland of the University of North Carolina, Greensboro. He showed a map of the United States based on research he and his collaborators had presented at the 2015 TEP conference. Those results, derived from data on the emissions characteristics of the electric grid through 2012, indicated that EVs were not a cure-all for emissions. Back then, driving an EV could cause more pollution than driving a gasoline car in many parts of the country, even though they were much cleaner in California and a number of other states (where most EV sales have been concentrated).

Holland then described the dramatic reduction in emissions that has resulted from how much cleaner the electric grid has become. Their look at the most recent data, available through 2017, shows that EVs are now cleaner than gasoline vehicles throughout a much larger portion of the country. The reasons?

One reason “is CO2 emissions, which have fallen 20 percent across this timeframe,” said

“What we see is a huge decline in the damages from the electric power sector throughout the whole country.”

—STEPHEN HOLLAND
University of North Carolina, Greensboro
Holland. “That pales in comparison to the decrease in SO$_2$ (sulfur dioxide), which fell about 80 percent over this timeframe.”

Putting the damages to health and the planet from power sector emissions in monetary terms, “What we see is the damages decline from $245 billion per year in 2010 down to $133 billion, so a huge decline in the damages from the electric power sector throughout the whole country,” Holland said. He highlighted the “substantial health benefits from a decline in emissions from the power sector, mainly coming from SO$_2$.”

Holland reminded the audience that this progress doesn’t mean that driving an EV is guilt-free, environmentally speaking. “When I plug in my EV, I am pushing the load up a little bit on the grid system, and this is increasing damages on the grid,” he said.

**EV Economics Write Small and Large**

Taking a step back for a bigger-picture view of the policy context for EVs, Erich Muehlegger of the University of California, Davis, offered audience some perspectives on the private and public economics of the matter. The goal of their research was to examine how well the existing policy environment aligns with the economic rationale for market intervention to advance EVs.

A starting point is the private economics, which are anchored in an EV’s lower operating costs compared to a gasoline car. The savings vary widely by geography depending on electricity and gasoline prices but are positive on average in all states, as illustrated on a map that Muehlegger displayed. He then explained how the public economics depend on the externalities associated with EVs.
with EVs. These include both those related to usage, such as environmental impacts, and those related to network effects or “spillovers” related to EV production.

“What we are finding is that the existing policy environment leads to a situation where the private benefits of adoption vary significantly in different parts of the country,” said Muehleggner. “Similarly, the environmental benefits don’t align very closely with private benefits that are created in the existing policy frameworks.”

The session’s discussant was Elaine Buckberg, chief economist at General Motors, who suggested ways to drive greater EV adoption. Buckberg said that while there is a lot of uncertainty about how fast the market will grow, some forecasts predict massive growth with a market acceleration between 2025 and 2030. She displayed a set of widely-varying projections, pointing out that they average to a projection that EVs will comprise 17 percent of U.S. new auto sales in 2030.

Although incentives are an important way to induce EV adoption, customer research provides a powerful guide to what will make consumers willingly embrace EVs. Buckberg echoed some of the previous speakers, when she mentioned addressing battery costs, providing a driving range comparable to that of conventional vehicles, improving the convenience of charging, and offering more model choices. Expanded model choice is coming: for example, the number of mainstream EVs in the popular SUV body style will quadruple from three in 2019 to 12 by 2021. She also suggested that investing in public education about EVs would go a long way.

**Session Three**

**WHAT HAPPENS WHEN POLICIES COLLIDE?**

Catherine Hausman of the University of Michigan’s public policy faculty served as chair of the TE3 session that looked at the complexities of the public policy landscape affecting EVs. The issues include the multiple policies in effect in China as well as how programs to promote EVs interact with policies to improve fuel economy and reduce GHG emissions on a fleetwide basis.

Zhenhong Lin, of Oak Ridge National Laboratory, and his colleagues drilled down on China’s dual-credit policy in China, which is effectively replacing the EV subsidies that the country is phasing out. The policy involves credits for complying with two regulatory programs, one targeting a firm’s fleet average fuel intensity and the other based on how many New Energy Vehicles (i.e., EVs) they sell. The former is similar to Corporate Average Fuel Economy Standards (CAFE) in the United States and the latter is similar to California’s Zero Emission Vehicle (ZEV) requirements.
Lin described how the subsidy phase-out has impacted EV sales, which previously had been booming in China. Nevertheless, their modeling projects ongoing EV sales growth, even though the interactions among the policies lead to questions about effectiveness, including the leakage concern when EV credits enable sales of less fuel-efficient gasoline vehicles.

Rubal Dua, research fellow at the King Abdullah Petroleum Studies and Research Center (KAPSARC), in Riyadh, Saudi Arabia, also centered on China’s EV subsidy phase-out in his presentation. Reminding the audience of the government’s rationale for the subsidy, “Chinese policy makers were using the subsidy to promote PEV production and sales,” said Dua. “It is part of both environmental and industrial policy.”

The study by Dua and his co-author compared the current subsidy to cases of no subsidy and targeted subsidy, the latter being a policy design that would be less costly to the government while being more cost-effective by aiming the subsidy at lower-income consumers.

Turning the gaze back on the U.S. market, Jeremy Michalek of Carnegie Mellon University presented research on how alternative fuel vehicle (AFV) policy interactions can increase U.S. GHG emissions. He and his colleagues examined the effects of incentives structures built into the fleet-average standards to encourage AFV sales. Explaining that there are both weighting factors and multiplier factors, they found that both factors “have the effect of permitting higher overall fleet emissions when AFVs are sold,” he said.

In addition, with states such as California mandating EV sales, the result is a greater number of such vehicles in the market. “Putting this together, you have state policies pushing for more AFVs on the market, and then the federal policy saying the more AFVs you have, the higher the fleet emission are,” said Michalek. He concluded by noting that, although policymakers now seem to view these trade-offs as worthwhile, they might consider other mechanisms to encourage an AFV transition that better calibrate the magnitude of the policy push to the externalities involved.
Session Four

WHERE TO GO FROM HERE?

TE³ closed out the day on a thoughtful, engaging and at times, humorous note with TE³ co-chair Tom Lyon, a U-M professor at the Ross School of Business and the School for Environment and Sustainability, steering a spirited panel discussion on policy tensions in the U.S. and across the globe. Joining Lyon on stage were Zifei Yang, a senior researcher with the International Council on Clean Transportation (ICCT); Patricia Monahan, a commissioner of the California Energy Commission; Julia Rege, senior director for Environment and Energy at the Association of Global Automakers; and Dan Levy, a senior equity research analyst at Credit Suisse.

Yang highlighted the fact that all major markets are moving toward lower CO₂ emission limits for motor vehicles, noting the crucial role that electrification plays along with efficiency improvements in scenarios for meeting a 1.5°C climate protection goal. She also shared results from an ICCT analysis of the European market indicating that it will be less costly to achieve the EU’s 2025–30 CO₂ standards if the transition to EVs starts sooner.

Monahan described California’s leadership across the range of transportation issues, including progress on reducing GHG emissions and on advancing technology. She said that the state has been taking a comprehensive approach to the issue, with policies and mechanisms in place to meet all the challenges for achieving the state’s carbon neutrality goal. For transportation, the programs include GHG emissions standards, a low-carbon fuel standard and the zero-emission vehicle (ZEV) mandate, which together will transform the sector to electrified mobility.
Rege, whose association represents numerous international automakers in the U.S. market, emphasized the fact that the transition to electrification is happening and that it will be crucial to build a sustainable market. The industry realizes the increasing pressure to address climate change and sell more EVs. Rege said that more EVs are coming and that a key to successful markets will be incentives and infrastructure as well as growing consumer demand.

Levy framed the challenges facing the auto industry in terms of the need to balance “two clocks.” The first is the “near” clock of navigating through the industry’s business cycle so that supply meets demand while maintaining financial health. The “far” clock involves the multi-decade transition to electric and autonomous vehicles. He said that the challenges are now being magnified as the global industry faces slower growth in the immediate future even with “the sound of disruption becoming louder” as time goes on. Levy also highlighted multiple factors—including social awareness, government policy and infrastructure support—that are shaping varying rates of EV uptake in different regions.

Lyon launched the panel discussion by asking the panelists to consider whether China’s push for EV deployment and the European Union’s stringent carbon regulations provides an advantage to manufacturers in those regions.

Levy pointed out that electrification is generally a regional endeavor. Although global harmonization of standards does help, automakers typically operate differently in each region. He also said that U.S. automakers have global electrification strategies in place, for example, with Ford slated to sell their upcoming electric Mustang in Europe.

**HIGH-VOLTAGE UNCERTAINTIES**

Lyon noted that while the research presented at TE³ was informative, the future remains quite uncertain. “Industries hate uncertainties, especially policy uncertainties,” he said. “As you look at this industry, what uncertainties are of the greatest concern? Are EV subsidies the biggest uncertainty, or are there other things that loom even larger?”

Rege acknowledged how the industry is well aware that it faces a lot of uncertainty at present. “Some of it is directly related to the fight between the federal government and California for regulation over greenhouse gases and zero-emission vehicles,” she said, “and some of it is just related to the transition in technologies.”

She noted a parallel between the situations facing vehicle automation and electrification. “When you go to a conference on automated vehicles and people ask ‘When is it going to happen?’ you hear everything from 5 years to 30 years,” Rege said, “That’s a lot of uncertainty.” She suggested that some public policy must be
devoted to support innovation, so the road to the future won’t be so rocky.

Levy agreed the auto industry and uncertainty are two things that don’t go well together, but the pairing is an unavoidable reality. “The auto industry is a giant industrial machine,” he said. “The generation of a product is 5 to 7 years, and consumer behaviors are very sticky.”

Monahan said automakers should remain proactive rather than reactive when dealing with EV industry uncertainties. “I would say to the auto industry, if you want regulatory certainty, do what Ford and Honda did, which is talk to California, cut a deal and then you have some certainty.”

Yang added some insights from a Chinese policy perspective. “From the government side, there is no clear idea of the total impact of all policies or [what happens] if they add more,” she said. “China’s government is testing different policies and they are not very clear about the market because it is so dynamic.” The second phase of China’s New Energy Vehicle mandate was recently delayed from 2020 to 2023, Yang noted, explaining that the reason is because policymakers lack sufficient clarity about where the EV market will be in another three years. “The government is still observing,” she said.

**TAXING QUESTIONS AND ANSWERS**

Lyon then turned the panel’s attention to the role of a carbon tax or gasoline tax in building the EV market. Rege said that automakers often point out the need for a mechanism to drive consumer decisions, saying that “Certainly, the carbon tax offers an opportunity.” Automakers have also been supportive of increased gasoline taxes.

Noting that some states have levied additional fees on EVs because it is believed that their use erodes highway funds, Rege remarked, “The reality is, it’s all of the more efficient gasoline vehicles that are paying less through the gas tax. Less than one percent of vehicles on the road are EVs.” Although EVs are not significantly impacting roadways now, she also noted that, “if we are going to keep increasing electrification, then we have to have a smarter way of approaching it than additional fees on one vehicle and a gas tax on the other.”

Monahan said she is a fan of carbon fees. One of the beautiful things about a carbon tax she said, is that it provides a steady stream of resources that can be invested in electric transportation, which would in turn bring down the cost difference and ultimately help the market. However, she also noted that, “if we’re looking for a solution for transportation and we are going to put all of our eggs in the carbon-tax basket, that is a bad deal. All of the economists in the audience probably already know gasoline demand is very inelastic,” she said. “You have to raise prices a lot to change consumer behavior.”
It was noted that raising gasoline prices has helped the adoption of EVs in other nations. Levy mention Norway, where the gas price is $10 a gallon. “Norway has no taxes on electric vehicles and a slew of other benefits,” he said. “It is not a surprise that EV uptake in Norway is probably higher than anywhere else.”

Joked Lyon: “So, would it follow that we should nationalize the oil industry here?” (referring to the fact that Norway’s oil company is largely state-owned). The audience offered titters of laughter and throat-clearing. “Alright. Just seeing if people are awake.”

**ELECTRICITY VS. COMBUSTION**

The flip side of the question about how fast the EV market will grow is the question of how long internal combustion engine (ICE) vehicles will persist, and therefore how long automakers need to invest in improving them. This issue was raised by an audience member, who asked the panel for their views about the fate of ICE vehicles.

“Public disclosures and comments on budgeting from automakers have indicated that budgeting toward ICE is going down,” said Levy. He pointed out GM’s approach to the issue, which is recently merging its ICE and electric propulsion groups into one broader propulsion group to find ways to share resources.

Monahan said that heavy-duty vehicles are going to be a lot harder to electrify, but that there are entities making such investments. She cited Ikea’s “last-mile commitment,” in which the company has pledged to only use EVs for all its last-mile home deliveries in cities like Los Angeles, New York, Paris and Shanghai by 2020. Monahan also noted that Amazon is investing in trucks from the electric vehicle manufacturer, Rivian, and that UPS is investing in alternative fuel options such as compressed natural gas vehicles (CNG).

As the end of the conference drew near, Monahan revisited comments made earlier in the day by Howard Learner and Stephen Holland. Learner had called out the continued reliance on coal in some states. Holland had noted EVs are not a cure-all for emissions and EV owners shouldn’t feel less guilty about driving. “I’ve got to respond to the comment about using coal when plugging in your EV,” she said. “I just think, because it takes so long for the vehicle market to turn over, we have to be looking more long-term.”

She noted that Holland’s research showed how the grid has gotten much cleaner in just a short period of time. It’s going to continue to do that because wind and solar are cheaper than coal, she pointed out, so that economics together with policy eventually are going to drive cleanup in the electric sector. “I don’t think you should feel guilty if you live in the Midwest and you are plugging in your EV,” Monahan concluded, “I think you should feel like you are part of the future.”

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—PATRICIA MONAHAN, California Energy Commission
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