



**ALTERNATIVE FUEL / ADVANCED VEHICLES TECHNOLOGIES & INFRASTRUCTURE REQUIREMENTS:  
BRINGING INNOVATION TO OUR STREETS  
NYU Kimmel Center, NYC  
June 14, 2011**

Rudin Center for Transportation Policy and Management  
New York University Robert F. Wagner Graduate School of Public Service

Sponsored by  
Con Edison of New York  
New York State Energy, Research and Development Authority (NYSERDA)  
New York State Department of Transportation (NYSDOT)

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**About the Conference**

This conference was organized with the support of a grant provided by the New York State Energy Research and Development Authority (NYSERDA) in partnership with the New York State Department of Transportation (NYSDOT). Funding was provided under the auspices of NYSEDA and NYSDOT's "Low Carbon Transportation Alternatives: Pathways to Energy Efficiency, Enhanced Economics, Sustainability and Livability" grants program. This program seeks to fund initiatives and research with the potential to reduce the carbon intensity of New York State's existing multi-modal transportation system, with this conference meeting the education and technology transfer objectives of the program.

In addition to joint funding from NYSEDA and NYSDOT, the Rudin Center received funding from Con Edison of New York for this conference. Con Edison supports the dissemination of knowledge and discussion of alternative fuels and advanced vehicles as a part of their stewardship of the region's energy infrastructure.

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**Welcoming Remarks**

*Mitchell Moss, Director, Rudin Center for Transportation, NYU Robert F. Wagner School of Public Service*

Professor Moss welcomed all participants and emphasized the local, national, and global scales of the issues being addressed at the conference. He underscored the importance of future-focused transportation research, of which alternative and advanced vehicle technologies are a

clear example. There are challenges in terms of the technologies, getting these vehicles to market, and getting consumers to purchase them. Professor Moss also thanked the sponsors of the event, Con Edison of New York, the New York State Energy Research and Development Authority, and the New York State Department of Transportation.

### **Keynote Address**

*Craig Ivey, President, Con Edison of New York*

Mr. Ivey placed new vehicle technologies in the context of their long history, including at Con Edison, encouraging everyone to learn to use new vehicle technology, save energy and protect the environment. He added that recent technology improvements and falling prices have combined to make electric vehicles an attractive option for Americans.

Ivey mentioned that the utility industry has a crucial role to play in new vehicle technologies. Indeed, while demand for electric vehicles (EVs) will start slowly, but then increase rapidly, Con Edison is ready and anticipating the challenges of charging vehicles on the existing electricity grid. Con Edison has been working with regulators to allow more flexibility in charging lower rates during off-peak hours. They are also working on new technology to enable vehicle owners to charge anywhere but pay for their electricity on single account. Moreover, at Con Edison, more than 40% of their fleet is comprised of alternative fuel or advanced vehicles, reduced their greenhouse gas footprint. Vehicle fleets will likely be ahead of others in terms of adoption.

### **Panel 1: Alternative Fuel Vehicle Technologies<sup>1</sup>**

*Moderator: John Zamurs, Sustainability & Climate Change Section, Statewide Policy Bureau, NYSDOT*

In introducing the panel presenters, John Zamurs mentioned that the New York State Department of Transportation has created a new office of Sustainability and Climate Change, which handles alternative fuel policy. Consistent with this initiative, close to 60% of NYSDOT's light duty fleet is already alternative-fueled. Still, "this is not sufficient." The state is creating a new energy plan to further reduce reliance on petroleum via increased energy efficiency. The strategy also includes support for the electrification of the transportation sector, as well as increased adoption of alternative fuel vehicles.

*Ann M. Schlenker, Argonne National Laboratory*

Dr. Schlenker started her remarks by briefly outlining various programs and initiatives at the US Department of Energy (DOE), including at ten national labs that do basic research, applied research, and engineering, in addition to deployment in the commercial sector. One of the key goals of DOE is to reduce greenhouse gases and energy use in the transportation sector, while maintaining comparable performance to today's standards. There are 240 million vehicles on the road and roughly 11.5 million new vehicles come online each year. However, hybrid

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<sup>1</sup> The New York Academy of Sciences conducted interviews on AFVs with three of our panelists: Ann M. Schlenker and Bruce Bunting. The podcast is on the Rudin Center's website at <http://wagner.nyu.edu/rudincenter/conferences/>

vehicles are only 3% of new motorized vehicles, making the current penetration of new technologies very minor. Yet, the reasons to adopt alternative vehicle technologies continue to coalesce, with major driving forces being the foreign trade deficit, increasing greenhouse gases, and the need for energy security. Still, impediments to adoption include the fragile but recovering US auto industry, unpredictability in gas prices, new technology vehicle affordability, infrastructure readiness, reliability, and the need for government standards.

There is no “silver bullet” vehicle or fuel for every consumer. A plethora of technologies, whether advancements in internal combustion engines, hybrid-electric vehicles, plug-in hybrids, natural gas, battery-electric, or hydrogen fuel cells will be implemented. Every manufacturer has plans for an alternative fuel vehicle within some technology class. GM indicates an electric vehicle should cost about as much as a water heater in ongoing electricity costs. Still, there is a need to refine technologies and bring down costs through wider distribution. Research on batteries that improve upon the lithium-ion battery is ongoing, but there are significant challenges in terms of cost. Other technologies are coming on line, however. We are entering a decade of discovery for the vehicle and the grid. At least 50% of vehicle sales are expected to be plug-in hybrids and/or EVs by the year 2050. Fuel cells vehicles are out on the roads today, and there has been a 30% reduction in costs of this technology. There is a four-year return on investment for plug-in hybrids, so there is some incentive to switch now. Battery technology and cost progress is the real enabler.

*Rich Kolodziej, Natural Gas Vehicles Association*

Mr. Kolodziej started his presentation by stating that there is no one panacea to replace petroleum. There will be a plethora of options and fuels in different parts of the country and he argued that all of them should be used in order to limit dependence on petroleum. However, even petroleum vehicles themselves are getting more efficient and clean. So he asked, “how can we move to different fuels?” Natural gas vehicles (NGVs) are an essential part of the broader move away from petroleum. Worldwide, there were 2.8 million NGVs in 2003 and 13.2 million today. All major auto manufacturers are currently making NGVs. Much of the conversation on alternative fuels and vehicles focuses on light duty vehicles, but he pointed out that heavy duty diesel vehicles use a quarter of the petroleum in the transportation sector, and there are few alternatives to diesel in the heavy truck sector. Eighteen-wheelers will not work with electric power, due to their weight and range requirements. Natural gas is the best alternative to diesel for heavy trucks. Currently, there are only 250,000 NGVs units in operation in the United States; and while that is a very small number the potential for the natural gas industry to penetrate the heavy duty market is great. Medium- and heavy-duty vehicles are “original equipment manufacturer” (OEM) vehicles, rather than “conversions” units. NGVs cost more because of their high-pressure, secured fuel tanks, but actual fuel costs can be much lower, providing a good return on investment for fleets that adopt NGV technologies.

Kolodziej concluded his remarks by stating that NGVs produce less of all the major pollutants, including 20% less greenhouse gases than diesel vehicles, in terms of well-to-wheels. Non-renewable natural gas is available in great supply, and estimates of supply keep increasing.

Natural gas fuel can also be made renewably from biomethane. Landfill gas can be used, thereby reducing greenhouse gas emissions from landfills by 90%.

*Bruce Bunting, Oak Ridge National Laboratory*

Dr. Bunting spoke about biofuels and advanced engine technologies. He described the Oak Ridge Laboratory's research focusing on liquid fuels, infrastructure, and engines. Most of the biofuel in the United States comes from corn, but there's a cap on corn-based ethanol, so it will be necessary to replace corn starch ethanol production with cellulosic ethanol. While ethanol is a gasoline substitute, it currently cannot be transported through regular pipelines used in the United States because it could harm the existing infrastructure, corroding pipelines by bringing in added humidity and/o water. However, ideally one could continue to use the existing *petroleum infrastructure*, both pipelines and refineries. Petroleum refineries have the most control over the quality and complexity of fuels. Unfortunately, biofuels can contaminate other fuels. Still, potential fixes are possible as demand for biofuels increase. Chemically making biofuels increasingly resemble petroleum will help them be transported through the existing infrastructure.

There are many technologies for creating biofuels. All have their challenges in terms of cost of the process or of the inputs. The simplest option is to supply a specific fuel to a specific consumer. Blending with petroleum-based fuels, as is already done, is another simple solution to overcoming some of the functional and supply problems with biofuels.

Dr. Bunting discussed advanced engine combustion technologies. There are many variations being tried, but all attempt to get the temperature and blending of fuel and oxygen just right for the cleanest, most complete combustion. By premixing and diluting the fuel, an engine can avoid the temperatures and blends that create either soot or nitrogen oxides. Advanced engines can balance inputs for a variety of fuels to optimize their combustion and their efficiency.

*Steve J. Weir, NYC Office of Fleet Administration, Department of Citywide Administrative Services*

The Office of Fleet Administration, Mr. Weir said, sees the use of alternative fuel vehicles as the right thing to do and relying entirely on foreign petroleum is not a smart idea. Alternative fuels and vehicles are not as subject to cost fluctuations as gas and diesel. He added that New York City abides by Local Law 38, which required the purchase of the highest-rated vehicles in terms of air quality that are commercially available. The City also follows Local Law 55, which mandates the reduction of greenhouse gas emissions by 30% by 2030, and is also using electric, plug-in hybrid, CNG, and biodiesel vehicles, as well as right-sizing vehicles to job requirements. The city has 4,000 alternative fuel vehicles today, including Chevy Volts. CNG is the fuel of the future for large vehicles.

Mr. Weir said that he has not seen many problems in the operation of alternative fuel vehicle relative to traditional vehicles. Battery packs have been robust, and CNG performance has been excellent. Still, the most reliable CNG vehicles are OEM, not retrofits. In terms of

infrastructure, electric vehicles are problematic in that there are no charging stations on the streets.

## **Panel 2: Required Infrastructure Investments**

*Moderator: Rae Zimmerman, NYU Robert F. Wagner School of Public Service*

Prof. Zimmerman emphasized that alternative fuel vehicles are part of our national security objectives and invited the panelist to discuss various aspects of the infrastructure requirements to support their broad adoption.

*Caley Johnson, Market Transformation Center, National Renewable Energy Laboratory*

In his remarks, Mr. Johnson stated that the National Renewable Energy Laboratory works with multiple technologies to help displace petroleum in local economies. He works to help groups decide which technologies are best for them. For instance, he educates consumers about ethanol fuel mixtures, which have "E" numbers describing the percentage of ethanol fuel in the mixture by volume (e.g. E85 is 85% anhydrous ethanol and 15% gasoline). The majority of the gasoline sold in the United States is E10. Therefore, in order to displace gasoline and increase ethanol usage there will need to be more E85 vehicles on the road and the fueling stations will respond to accommodate the demand. He added that E85 has been growing since its introduction, and will continue to grow.

The natural gas infrastructure (in terms of NG stations) peaked in 1996 and decreased through 2006 before starting to grow again. However, while the number of CNG stations decreased, the overall volume of natural gas used for transportation has actually continued to increase. NGVs have now refocused to the vehicle-fleets market. The primary driver for NGVs is that natural gas has a pretty reliable fuel savings per gallon. Also, natural gas is much more reliable in terms of cost fluctuations. It requires a larger up-front investment, but then that cost is paid for with fuel savings. The larger the CNG station, the quicker the payback will be. The more you compress the natural gas, the more expensive the station infrastructure. Slow-fill (less compression) stations are fairly inexpensive, with fast-fill (highly compressed gas), and liquefied natural gas stations going up in cost. There are major advantages to clustering stations throughout an area. More and more CNG stations are open to the public, and there are advantages there, too. LNG is used in eighteen-wheelers with a range of over 500 miles. While these stations are at a much earlier stage of development, there will not need to be as many stations. Instead, stations can be spaced about 500 miles apart.

He added that methane wafts into the atmosphere, where it is 25 times worse than carbon dioxide in terms of its greenhouse effect. Thus, to capture methane from landfills, industrial farms, and wastewater treatment facilities can have a very positive impact on climate change. Right now, only 2% of economically feasible methane is being captured from livestock operations. This methane can be used for vehicles, or for electricity generation.

Mr. Johnson concluded by emphasized the importance of coordination among all of the industry and local groups focusing on alternative fuels and vehicles, saying that everyone can learn from early experiences, negative or positive.

*Stephen Schey, ECOtality North America.*

Mr. Schey focused on the electric vehicle (EV) infrastructure, and what ECOtality is doing to improve that infrastructure. They have been involved with most of the EV initiatives since the late 1980s, testing different types of alternative fuel vehicles but focus on electric vehicles. He stated that “EVs are here already” and there are multiple types of EV charging stations, which are designated as Levels 1 and 2 that deliver AC power to a vehicle, which then converts the AC to DC power, as well as DC fast-charging stations. Level 1 charging stations roughly provide enough energy for 3 miles of travel in 30 minutes. Level 2 charging stations are much faster charge, fully charging Nissan Leaf in 4 hours versus 20 hours at Level 1. A DC fast charger is better yet, taking just minutes to recharge a Leaf. The Chevy Volt and Nissan Leaf use a standard AC connector J1772, so one connector will fit all electric vehicles. Leaf also has a fast DC charge connector.

In terms of building the charging infrastructure, Level 2 chargers would make sense where the vehicles are charged in an hour or more. Charging is most likely to occur first at home, second at work, and then at places where people spend a relative long time, such as shopping centers. DC fast chargers should be built where people spend only short periods of time. Gas stations, convenience stores, and fast food stores are examples.

He added that one important issue is to identify revenue sharing streams for the charging sites in order to encourage build-out. In 2009, DOE gave an award to ECOtality to do a charging infrastructure study. There are about 50 partners in the project. They will be installing about 14,000 Level 2 stations at homes and public facilities across the country. In exchange for the charging station, ECOtality will collect and analyze information on usage. They are engaged in a planning effort to identify where chargers should go. It’s important to look at the long range and make sure that 10 years from now, there will be infrastructure accessible to everyone and not just to today’s high end users.

*Brian Asparro, Green Charge Networks*

Green Charge Networks focuses on system broad solutions, matching supply and demand. Based in Brooklyn, they started in 2007 and Green Charge is working with Con Edison on managing the grid as vehicle charging increases. One major area they are looking at is distributed energy storage. Lithium-ion batteries, located at charging stations, can be used to reduce strain on the grid. Presently, the company is installing electric vehicle charging facilities at a variety of retail locations to assess potential reliability issues. One of the key challenges is finding ways to conduct EV charging at facility without creating electric congestion on the grid. Utilities need to understand where the problems and weak spots lie on the grid. Increased demand for EVs will only make the problems worse. The infrastructure is not cheap, and doing so before the demand comes means that companies and utilities have to consider future

rewards. With battery-based energy storage at retail facilities, retailers can reduce overall energy costs with a 3-5 years return on investment.

*John Shipman, Engineering & Planning, Con Edison*

Con Edison uses a 20% biodiesel blend for its entire heavy truck fleet. Mr. Shipman echoed that there is no silver bullet technology, and everyone must diversify their vehicle's portfolio by fuel and technology. Biodiesel has a low adoption cost, but the volatility of that fuel's cost, as a commodity, has become an issue. Still, diesel engines whether fueled with petroleum or biodiesel have improved tremendously in terms of pollution reduction. CNG vehicles have come back after a contraction in the market when building of OEM type CNG vehicles was stopped. The CNG infrastructure would have to be reinforced if everybody were to use it, but it will likely be only one component of the mix.

Con Edison estimates there will be 100,000 to 150,000 EVs in New York area by 2020. They believe that from a load perspective, this will be manageable since that is less than 1/10 of 1% of today's total load. Their analysis indicated that only 2 to 6 percent of area substations would have to be upgraded to handle the load to accommodate higher demand. Residential and local parking garage customers should be able to charge off-peak. Those driving into the city may want to charge during peak hours, however. Fleets needing to constantly charge will also need more intensive load management. Still, Con Edison believes they can manage the peaks and make use of existing infrastructure to supply electricity for EVs.

### **Panel 3: Policies - Moving Towards Implementation**

*Moderator: Richard Kassel, Clean Vehicles Project, NRDC*

*Panelists: Christina Ficicchia, Lower Hudson Valley Clean Cities Coalition*

*Ari Kahn, EV program for the Mayor's Office of Long-Term Planning & Sustainability*

*Rich Kolodziej, Natural Gas Vehicles Association*

This session was a moderated discussion among the panelists and audience on policies necessary for implementation of alternative fuels and vehicles to be successful. The following summary highlights key observations made during the discussion.

*Topic: Where Will Growth Occur?*

Christina Ficicchia: Even a couple of years ago, there were many barriers to fleet operators in terms of available technology. Those barriers are now going away. On the CNG side, most of the heavy duty manufacturers have CNG options; electric vehicle manufacturers are also starting to make medium- to heavy-vehicles available, and we have seen progress in biodiesel fuels. People are testing and running all of the technologies. We also need to address the fact that battery technology needs to be couple with other alternative fuels. Hybridized biofuel trucks are one such example.

Rich Kolodziej: Electric and natural gas vehicles are going to be the vehicle technologies that grow over the next decades. They are less expensive to operate. Ethanol and biodiesel cost more for fuel, even though they are cheaper to start up. Unless ethanol and biodiesel can

reduce costs, they will fall by the wayside. The subsidy for biodiesel is critical for people to use it. Trash trucks and buses are a fast growing market for CNG. Still, all these assumptions based on gasoline vehicles staying the same as they are today, but they're going to continue to get more efficient and remain competitive.

Ari Kahn: The growth will be in the suburbs, where people have garages to charge. Indicators of potential EV adoption suggest that in New York City major adoption will begin in downtown Brooklyn, Western Queens, and Manhattan. EV production has reached some maturity, but batteries are still incredibly expensive. We don't know whether EVs may just benefit from industrial process improvements, or a technological breakthrough in batteries will make them much more attractive.

*Topic: Policies for Implementation*

Ari Kahn: Most of the demand is from early adopters. We need to remove barriers to entry and improve education. We have to make sure people can have a charge in their garage at home or parking lot. The City can help with policies for off-peak charging, and getting second meters in home. There is the \$7,500 tax credit on electric vehicles, and a tax rebate for installation of EV infrastructure. Have they been effective enough? It's hard to say.

Rich Kolodziej: What can you do to make it more economically attractive? In other countries, the government sets the price of fuels. In Argentina, they make CNG 35% cheaper than gasoline, and therefore 15% of vehicles run on CNG. We can encourage adoption with mandates, but they are a blunt policy instrument. Incentives are much better tools, and people can either choose to take advantage of them or not. We ought to tax gasoline and diesel more, and use those funds to support alternative fuels and technologies. Still, that is not going to happen in our political environment. Even the building of the Interstates had to be sold to Congress and the public, by putting it in a defense bill. We could change existing policies, though. For example, the Federal government pays 80% of transit bus costs. We could change the policy to 50% for diesel and 100% for CNG buses. That wouldn't change total cost of the subsidy, but it would change adoption rates for CNG buses. At the Ports of Los Angeles and Long Beach, they instituted a surcharge on cargo and use this revenue to pay for alternative-fueled trucks. For airports, there is some funding for alternative-fueled tarmac vehicles, but that could be expanded to include hotel shuttles and other ground-based services.

Christina Ficicchia: The Federal government has to take some stance and create and overarching policy to move everyone towards adoption.

*Audience Discussion*

The session concluded with discussion among the audience and panelists. One audience member brought up the idea of a "golden carrot" incentive from government to encourage the commercialization of alternative fuel and technology vehicles. The panelists generally responded that there are already large stream of funds being invested in vehicles and fuels, so an additional golden carrot incentive is unlikely to have a much additional effect. Other topics included the political problem of getting America to stop importing foreign oil and the need to



address fueling infrastructure for CNG vehicles. Mr. Kassel commented that we US consumers seem to be reaching a turning point, and that the combination of high gasoline prices and the change in CAFE standards will, within a decade, result in Americans wanting to take advantage of a wide variety of vehicle types.

### **Concluding Remarks**

*Marta Panero, Deputy Director and Research Scientist, Rudin Center for Transportation.*

In closing remarks, and after thanking the conference participants and sponsors, Dr. Panero emphasized the need to continue to advance the AFV agenda. She said that this may include further research about AFV technologies and policy innovations as well as practical applications that would result in the broad deployment of AFVs. Panero then invited participants to visit the Rudin Center's website for the conference summary and presentations and related information.