A New Era for Clean Transportation: Pathways for Clean Technologies
CALSTART Annual Meeting and Blue Sky Award Luncheon
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Proceedings

Note: This document is intended as a summary of the CALSTART 2015 Annual Meeting, not a direct transcript. Quotes are paraphrased and incomplete. No statements from this document should be reproduced or used to relay the views of the individuals cited herein.

8:20 am  CALSTART Member Company Tech Talks
As part of the CALSTART Annual Meeting, CALSTART a few member companies were invited to briefly discuss their company products and technologies.

John McNichols,  Product Director, Crosspoint Kinetics
Crosspoint Kinetics manufactures a post-transmission hybrid, which does not affect EPA certifications. The transmission is designed for a stop/start urban environment. Testing shows that the technology offers an 18% reduction in NOx and a large reduction in CO2. The technology has been field tested and verified with over 9 million miles on-road.

Tim Reeser,  President, Lightning Hybrids
Lightning offers a parallel hydraulic hybrid for classes 2-8. The post-transmission installation is a retrofit and can be installed on many different platforms. The company is currently offering the product in the US, Canada, Mexico, India, Turkey and the United Kingdom. The hybrid offers a 90% NOx reduction and a 30% GHG savings according to recent testing in Colorado. A second test, using gasoline instead of diesel, there was a 400% improvement in NOx.

Larry Fromm,  Vice President, Business and Strategy Development, Achates Power
Achates is currently contracting with major OEMs to produce their modernized opposed piston engine. The Achates engine is 86% more efficient than gasoline, and 30% more efficient than conventional diesel, and less expensive than either.

8:30 am  US EPA Policies and Future Clean Transportation Technologies
- Christopher Grundler,  Director, Office of Transportation and Air Quality, US Environmental Protection Agency

There is no doubt that all of the progress we have made started in California – I am a big believer in California as an incubator for solutions to out nation’s problems. People with goodwill and ingenuity get together and roll up their sleeves.

We need to remind people what has been achieved and we have achieved a lot:
  - The US has adopted 3 separate sets of GHG standards for vehicles that are final and being implemented. These standards will reduce GHGs by 50% in 2025.
  - We went to London to achieve efficiency standards for oceangoing vessels.
  - We are celebrating 10th anniversary of Smartway program that is the envy of the world.
  - With respect to clean air, new heavy-duty trucks are 90% cleaner than they were a few years ago.
  - We have reduced sulfur from fuels.
  - In March of 2014, EPA established light duty vehicle standards and standards and 2015 will be a big year for air quality Tier IV standards take effect.

Our planet is changing. That’s a fact…this is based not on theory, but on millions of measurements taken over decades. The US has taken some very serious steps to address this. The Economist calls light duty vehicle standards the 6th most important climate measure. Still, far too many Americans are still breathing unhealthy air. So this isn’t just climate. Our work is not done.

Sequestration has not been kind to the EPA, so we’ve had to make tough choices:
1) We need to keep promises we made to the public about the benefits of clean air. Benefits don’t accrue unless EPA and ARB do their job in implementation and enforcement. The industry is spending billions to achieve these targets, so we need to ensure fair competition and we need to rethink this business. To this end, we are forming compliance partnerships with ARB and Environment Canada.
2) Vehicle standards and building on those efforts.
a. Heavy-duty truck standards need to be met on target. The EPA has spent millions of dollars and has partnered with key groups. We’ve held over 200 meetings with stakeholders, from dealers to users to NGOs to trailer companies. It has been an enormous, rigorous effort to create this body of work. The new standards are very different and much more ambitious than phase 1 standards, which were not technology-forcing.

b. We are also undergoing a midterm evaluation for with regard to light-duty vehicles, which could mean the standards are kept, strengthened, or weakened. Technical rigor and robustness of April 2018 midterm review decisions will rival or exceed our original efforts to create the standards, and this will be a very significant decision.

3) We are working toward long-term transportation fuels strategy. The Renewable Fuels Standard (RFS) has been very challenging for EPA to implement. The RFS only deals with a small portion of the transportation fuels supply. It does not look at whole transportation fuel pool as California does. I see opportunities across entire fuels sector. It is time for the EPA to review the requirements that have built up and modernize the policy. Currently, there are unnecessary burdens on EPA and industry. There are opportunities we need to put in place to implement a long-term strategy.

4) We need a place-based strategy. California efforts around clean freight and ports are important. The EPA needs to do more along these lines, with a national sustainable ports strategy.

EPA in the News

- The public needs to know what the car companies are doing to comply with standards. A recent report showed that the industry as a whole is beating the targets and adopting technology faster than anticipated. Flexible compliance mechanisms are working, and there is trading occurring. We are producing vehicles that are beating the standards and that people are buying. The industry as a whole is ahead of the game, there are more choices for consumers, etc. The National Automobile Dealers Association has issued a report showing that fuel economy is the number one deciding factor for purchase, and this has never happened before.

- On RFS, the House of Representatives is having a hearing tomorrow morning. The EPA is committed to address 2014, 2015, and 2016 standards as soon as possible in the new year. We need longer term signal, need to create certainty, and need to address fundamental issues in this policy arena. Mandates are running up against new trend of flattening/falling gas consumption. This makes blending more difficult, and there are infrastructure challenges. Also, cellulosics have been slow to develop. We need to put the RFS on a manageable track. It is too early to throw in the towel on these fuels.

- The EPA is creating a Clean Power Plan. Cleaning up the grid is also good for transportation.

- The US-China climate agreement is a big deal, with the largest polluters on the planet working to achieve new legally binding agreement in 2015. This has real ramifications for international climate policy, and the US is potentially agreeing to double the pace of reductions post-2020.

The EPA needs to engage with California and others to figure out what is achievable in the long-term, and how we can get there. Vehicle technology alone is not going to do the job. Standards alone are not going to do the job. We need to lower carbon in fuels and need to improve infrastructure. We should expect more engagement with the public. But early results are hopeful and we can see big changes in transportation sector.

Questions and Answers Session

John, McNichols, Crosspoint Kinetics: You mentioned flexible compliance. Can we talk more about this?

Grundler: It is important not to inhibit innovation. That is what will save us. There are real-world reductions that are not captured in test cycles. And these reductions should be recognized and given credit. Our ability to move fast is constrained and there is tension between certainty and speed. Need to really dig in and look on case-by-case basis.

Scaling Up the Next Generation of Clean Technologies

- Dr. Cheryl Martin, Acting Director, Advanced Research Projects Agency – Energy (ARPA-E), US Department of Energy

About ARPA-E

ARPA-E was formed five years ago, and the agency reports directly to the Secretary of Energy. All ARPA-E staff members are recruited from private industry, national labs, and academia, not government. Each of the 100-person staff spends three years at ARPA-E. I came from Kleiner-Perkins.

ARPA-E looks at problems in new ways. How do you parse a problem in new ways to get new eyes on the problem? As an example, why not transform plants to be more fuel-like, rather than focus on the energy-intensive exercise of transforming existing plants into existing fuels?
Bringing new ideas to the market is a low-yield process. Why do many new ideas fail? It could be they do not have the right team, they may have the wrong idea, or it might be poor implementation. In addition to simply assessing technical potential for success, ARPA-E goes through the process of assessing potential success in the marketplace, a far more involved process.

ARPA-E gives out $3M grants that last three years. Half of awards go to academics, a quarter to small companies and a quarter to bigger companies in two divisions: transportation and stationary energy technology.

A significant focus is placed on what happens immediately after the three-year grant. How is the grant recipient poised to succeed at the conclusion of the grant? ARPA-E brings expertise in technology-to-market. They provide expertise in markets and techno-economics; skills and resources; and stakeholder engagement. ARPA-E can work to change external factors while a recipient is under award (such as adjusting specifications from regulatory agencies) to increase the market acceptance of new technologies after the three-year grant.

Success stories of ARPA-E have common themes including new technologies and ideas that blur existing lines of categorization. While projects are differentiated between transportation and power production, in several cases there are solutions that address both.

Some examples of successful ARPA-E projects include:

- Oregon: On-board dynamics that can compress natural gas using the pistons in the engine.
- Prious Power - solar panels with control systems and grid-level storage
- Harvard – Batteries from rhubarbs, quinones.
- Oak Ridge - grid regulation on the power lines directly, tuning the grid up and down.

The Next Generation of Clean Fuels
Moderator: Jeff Reed, Director, Business Strategy and Advanced Technology, Sempra Utilities

- Rebecca Boudreaux, President, Oberon Fuels
- Peter Rocha, Corporate Business Development, Renewable Energy Group
- Ed Kjaer, Director, Transportation Electrification, Southern California Edison

Jeff Reed, Sempra: Sempra is in two non-attainment districts, SCAQMD and the San Joaquin Valley. The challenges (to attainment) can be addressed through continued improvements and efficiency. Blending and increasing supplies of renewable natural gas and renewable hydrogen will possibly help to address the challenges as well. Sempra is optimistic about the supply of resources. With technologies over the horizon such as artificial photosynthesis, we can make renewable natural gas, but there is no well-formed commercial framework for RNG. It’s a valuable resource in terms of renewable attribute, but there is no well-developed mechanism for recognizing the value. Projects aren’t bankable. We need to either solidify LCFS/cap and trade or look at other concepts (like RNG standard). Whatever the mechanism, certainty is biggest barrier.

Peter Rocha, Renewable Energy Group: Biodiesel is REG’s predominant business. The company has been listed publicly since 2011. In addition to biodiesel, REG has expanded to other fields. We recently acquired Syntroleum, a renewable diesel facility with a patented portfolio of gas to liquid technology and a capacity of 75 million gallons/year. We began shipping renewable diesel last month. We recently started RNG Energy Services, which operates out of Nebraska and offers blended services – selling blended products from B2 to B20 from different terminal locations.

Ed Kjaer, Southern California Edison: SCE is operating 200,000 plug-in EVs in the US. We are seeing good growth from the electricity perspective with 12-13% of national PEV sales, including 1200-1300 new customers per month. As we pursue a sustainable alternative to petroleum, there are near-term and longer-term players. No silver bullet, but lots of silver BBs. Will need it all. Electricity and NG are delivered by ubiquitous, secure systems. Both are ready. One neat aspect of electricity is that whether it is GHG, air quality, system integration, electricity makes a lot of sense. Electricity has potential and tremendous asset. Our near-term focus needs to be fueling for EVs and NGVs. This buys time to develop other pathways.

Rebecca Boudreaux, Oberon Fuels: Oberon uses a small-scale process to convert waste (methane) to DME. DME has been around for over 30 years, and has been used in development on the transportation side since the 1990s. It is a simple fuel with diesel-like performance, but burns clean so there is no DPF and it is easier to control NOx emissions. DME has a simple infrastructure – it is low pressure, the dispensers are inexpensive and it pumps at the rate of diesel. Oberon has a pilot facility in Imperial Valley producing fuel-grade DME for Volvo truck demos, and we are currently helping to create a regulatory framework. Oberon has received an EPA pathway qualifying for the renewable fuel standard.
Reed: What are scale challenges? Logistics, cost, etc.?

- **Rocha:** REG is at scale today, but we need CEC and other funds available to scale up. Blending may be one of the challenges. We are looking for opportunities to develop infrastructure and partnerships to increase the infrastructure availability. Renewable diesel fuel is a fungible commodity that we would like to provide more to the market. Infrastructure is the limiting factor.

- **Kjaer:** The electrical grid in the US is massive and is adapting faster than the load from transportation that is hitting it. From a supply perspective, transportation won't affect the grid that much. The grid is not a static entity. It is constantly adapting. We replace transformers each year to help the grid adapt to the new normal of transportation electrification. The last 50 feet is where the work is needed, with home charging, workplace charging, state parks. Edison wants to do 5 year charging pilot program with up to 1500 chargers to validate assumptions and judge the market support and customer interest in doing this. This will have the effect of doubling eVMT of Prius or Ford, adding 5 miles to a Volt. The grid is so big that this is not a big stretch. Of all the fuels we are talking about, NG and electricity are really ready to go now.

- **Boudreaux:** The challenge for us is building the coalition to commercialize DME as a transportation fuel. Volvo is the frontrunner, but we need other OEMs to step up. Off-road – construction and mining – provide a huge opportunity because infrastructure can be addressed (because of DME’s similarities to propane).

Reed: What regulatory/policy barriers need to be addressed? What are your thoughts on LCFS 10% target?

- **Boudreaux:** When the Low Carbon Fuels Standard was initially released, fuels such as DME weren't even in consideration. But if you let industry innovate, there are new solutions. We can do this.

- **Rocha:** We need a Renewable Fuels Standard that looks several years into the future. Regulatory uncertainty has been a real problem. Lapsing blenders tax credit is killing small companies. With greater certainty, REG would bring more of their facilities online.

- **Kjaer:** Sometimes on the policy side we let the perfect be the enemy of the good. We try to pick winners. California Public Utilities Commission is looking to make a decision about how utility monetizes investments and how they return this to consumers. Utilities as regulated entities can be audited, and can monetize credits to return the value to customers.'

Comments to fleets from panelists:

- **Boudreaux:** As a fleet manager, you have to be concerned with the operations and not worry about what is burned in the engine as long as it meets regulation. As a producer, it is important to engage and provide information on how a particular fuel can make the business better.

- **Kjaer:** EVs make a lot of sense in light duty arena. For medium and heavy-duty, it is harder, and there is some development work going on with converging electricity and natural gas.

- **Rocha:** ...biodiesel reputation .... Blending standard BQ 9000 standard that the fuels meets. If there is any reluctance due to previous history, educate yourself and ensure yourself that has changed.

Renewable Fuel Standard

- **Rocha:** We welcome the standards that the policy put in place as it removes regulatory risk from the equation.

- **Reed:** If you look at what is required to make these fuels available, there is not enough supply to last in the long term. We’ll need conversion facilities similar to IPP projects and we need a security packages with it. Without certainty, determining the value of the resource is hard. There is no corresponding framework in place to create s long-term degrees of certainty in order to get financing.

- **Boudreaux:** It is important to have incentives in place or credit in place in the long term.

Reed: With regard to diesel, is there a policy clash between the non-renewal of RFS, and LCFS, and NOx standards?

- **Reed:** What will the future look like with somewhat conflicting goals of state and federal government?

- **Rocha:** The way Low Carbon Fuel Standard is designed it will need every drop available. We to get resolution on other issues and help ARB meet that goal for 2020.

Question on delivery of service to mobile sources like vehicles:
• **Kjaer:** It’s a brand new use of the commodity and that is exciting. How you make the fueling experience as seamless as possible is the question. What is emerging is that all this thinking of vehicle grid integration and bidirectional energy flow... The potential is there but trying to rip it out of the lab and is taking our eye off the goal. Fundamentally we need to get more cars in the study and then start to shape it. We have to have the research and development for nearer term activities versus the future.

Reed: Are there any real barriers left to getting the fuel to the market?

• **Boudreaux:** With respect to DME, the fuel does not have to be registered but California needs the fuel to be certified. ARB has not certified it as a fuel since 1992. On the engine side, both CARB and EPA have to certify the engine.

**The Next Generation of Efficient Transportation Technologies – A Fresh Look at Alternative Engine Technologies and Advancements in the ICE**

Moderator: **Jerry Hirsch,** Automotive Business Writer, Los Angeles Times

Speakers:

- **Craig Scott,** National Manager, Advanced Technologies Group, Toyota Motor Sales
- **Paul Miles,** Manager, Combustion Engine Research Program, Sandia National Laboratory
- **Jan Hellåker,** Vice President, Transport Solutions and Services, Volvo Trucks

Scott: The Toyota Mirai gets a range 300 miles, which is unremarkable in that it drives like a regular car, but remarkable because it drives on hydrogen. The core of the technology is done in house. Sales will start around December 20 in Japan, and in the US cars are expected in the fall with production starting in the summer. Sales will be limited by accessibility and availability of infrastructure.

Hellåker: Volvo has a global viewpoint with different regulations in different regions. Fuel prices are very low right now, Five years ago we were talking about peak oil and now no one is. The question is if regulation or standards will create innovation that will trickle into the US market. Volvo’s development cycles are so much longer so we’re not affected by current drop in prices. Fuel prices in Europe continue to be high on a day-to-day basis. We need to move our eyes from the tailpipe, but particularly for commercial vehicles it is about the entire operations cycle. On the US Department of Energy Super Truck project, we’re working to improve efficiency by 50%. Another option we are looking at is connected vehicles. They will open up more opportunities for making transportation more efficient...some reports say by 50%. Automation will go in that direction, too. I would like to see CALSTART place a much stronger emphasis next year on connected vehicles.

Hirsch: General Motors will come out with a Cadillac model in 2017 with a car that talks to a car but it will unfortunately talk to only a few other Cadillacs on the road. Even if NHTSA completed its rule-making and mandated that vehicles talked to each other, how far out is that?

• **Hellåker:** Some researchers are indicating 5% penetration would have a significant impact on this development. In the US developments are driven by the US Department of Transportation because of the safety emphasis. They need to look to environmental possibilities, too.

Hirsch: What is the coolest development in internal combustion engine technology on the horizon?

• **Miles:** Sandia National Laboratory is a US Department of Energy laboratory that has been going strong for about 40 years. We only market ideas and knowledge. What we really do is try and understand what is happening in the internal portion of the engine and the combustion process. We use laser diagnostics and other things, but what we’re trying to identify are the limits we can reach on these engines in the future. Fuel cells and hybrid electric will continue to grow. The internal combustion engine, though, is here to stay for a long time. The most interesting development—we work closely with the auto industry and advanced combustion is one of the more interesting prospects. We can demo 30% efficiency advantages. The other thing is the talk about a national fuels policy. In 20 years of working with engine companies I’d always heard about gasoline and diesel and now at least the question is being asked if there were another fuel what would it look like. Certainly DME is one candidate. We’re looking at 40-45% efficiency gains (laboratory numbers).

Hirsch: If we can get 30-40% in the market place, what does this mean for EVs and fuel cells? Why would we erect a lot of new infrastructure if the internal combustion engine will work?

• **Scott:** Advanced batteries are for longer-term plays. At Toyota, we talk about the next 100 years. Planning for the next fuel is something we do today. Just because the internal combustion engine is strong, it doesn’t negate the need for planning.

Hellåker: We (Volvo) will take advantage of the internal combustion engine and any improvements.
• **Miles:** We (Sandia) don’t want to pick “winners”, as they can serve different market segments.

Hirsch: Elon Musk (Tesla) has described the nascent technology as the hydrogen “fool” cell, and says it is good for a rocket, but not driving around on streets. When we look at fuel cells, might it be better used in trucking with a central fueling infrastructure? Are we looking at the technology in the right place?

• **Hellåker:** We’re now interested in fuel cells for APU applications.

• **Scott:** Why do we have to choose only the car or Class 8 trucks? Or forklifts and small subcompacts? The answer is we can.

Hirsch: In the near term, where do you see advances from fuel economy coming when we look at the ICE?

• **Miles:** There are a lot of DOE programs aiming at demonstrating 25% fuel efficiency advantages, and it is largely based on transmission, tires, aerodynamics and has very little to do with the combustion system. Maybe there is a potential for modifying fuel supplies without introducing new fuels. Higher octane and higher cetane fuels can improve efficiency by allowing increased compression ratios.

• **Hellåker:** We’re continuously following the developments, but the short-term solution is to reduce weight. There’s a lot more to be done.

• **Scott:** Hybridization is the low-hanging fruit which we’re applying across our whole line. In 13 years the mental mind shift has changed dramatically. In 2001-2003 hybrids were mocked; now they’re so common they’re almost overlooked, but still hybrids only represent a few % of sales.

### Questions and Answers Session

**Charles Mendler, ENVERA:** Super Truck has been terrific. I think there’s been a lot of improvement taking place through engine downsizing. We’ve entered into a transition period.

Hirsch: So, where do you think the potential is for high-efficiency gas engines vs. diesel engines?

• **Miles:** This is into the advanced combustion regime where people are getting very high efficiencies. I think there’s a crossover, but the question is what is the best fuel and some are saying it might not be either.

**Tom Fulks, Bosch Diesel Systems:** I have a question for Jan (Hellåker) with regard to the Super Truck program. I wanted to get back to the question of whether we should we be picking winners— Have we, in California, for example, already decided that electric drive is the solution given the low-carbon investment plan adopted last June? Philosophically is that the right way to go?

• **Hellåker:** Any engineer prefers to not be given a specific technology. In our business where we are driven 100% by our customers’ bottom line, there isn’t a good business case for choosing hybrids. On the bus side it is different.

• **Miles:** These technologies can coexist and they serve different segments of the market so let’s not restrict ourselves as they all have a role.

**Darren Post, ALT-e Technologies:** When we do hybrids with different vehicles, motors and inverters, you really can’t develop a solution that works for electric controller A and B. Right now we need a point where the engine has a modularity so the cost can come down. Any thoughts on that vision? People are asking us to look at hybrid electric diesel or fuel cell. Customers can afford a small fleet but can’t scale it. Thoughts?

• **Scott:** At these early stages (hybrids are still early) there are a lot of things that need to happen. We need to learn how to modularize and build things across platforms. That takes time. Our lifecycles are 5+ years. In the near future you’ll see some noise from Toyota about this.

• **Hellåker:** This is an important issue. To our advantage, we own the entire drivetrain, which makes it easier for us, but the case isn’t yet there.

**Paul Wuebben, Carbon Recycling International:** Toyota deserves credit for great progress. Our company is the world’s largest renewable hydrogen producer. I wonder if you see any value to taking renewable hydrogen and refining it with carbon dioxide to get you into a sustainable liquid fuel path? It would be an open fuel standard instead of a renewable fuel standard?

**Carol Sturman, Sturman Industries:** If you have the right tools you can do compression emission with any fuel and there’s a lot of optimization that can be done to get much higher efficiency today. Toyota’s NH3 is quite interesting.
Hirsch: One focus is developing technology that can be done at a cost effective point for the business that uses the products. For fleets is there a point where we can take the driver out of the truck and what does that allow the industry to do?

- Hellåker: The fact is our ability to operate in a confined environment is going to enable that potential much sooner in passenger cars. There is one halfway step, which is platooning. You save between 10-15% of the fuel and that is a real low hanging fruit. It’s more of a challenge to find the truck to platoon with. For the next step, you can make a few things more efficient if you can take out the driver completely. That will be a while.

Hirsch: If we take the driver out completely can we change the cab?

- Hellåker: We’re in an EU project developing a new type trailer that has its own hybrid drivetrain so it is adaptable to fit whatever you are carrying.

Steve Sokolsky, CALSTART: Maybe a more intermediate step, something we’re doing with the Army is with connected vehicles and convoys. What should we do to encourage that?

- Hellåker: The problem is that the cost pressure is different from a more typical fleet, but we are following that already. We are under contract with FHWA so will be operating a 3 truck platoon.

Bill Van Amburg, CALSTART: We’re hearing about multiple technologies and fuels and I believe that’s being driven by performance-based standards. When you come to systems approaches, do we have any policy drivers pushing us that way and what are the tools that would help?

- Hellåker: In the US, there’s a lack of communication between DOE and DOT that could address that problem. We won’t survive in this world unless we get involved with a central air traffic control system or we’ll die from congestion.

- Scott: We’re trying to take advantage of policies already in place and thinking about how we could create a system.

Hirsch: So California has ambitious goals on emissions, as does EPA which is fostering the development of technology, but when I look across the entire US…our priority is the absolute cheapest energy. The goal is to have 15% of new car sales to be ZEV or CAFÉ by 2025. Are these goals truly achievable given the political environment and the consumer psyche?

- Scott: That’s an economic policy masquerading as an energy policy. Are the goals achievable? We’re making the best shot at it. Nobody had any idea that the Prius would become so popular. We don’t know what we don’t know. California is unique and this technology needs to move beyond CA and the US.

- Hellåker: If it can happen anywhere it would be California, and that’s why we’re engaged here—but we like working with government agencies because of the ambitions they have.

Hirsch: The way policy is devised now, are we truly, as a nation, engine or powertrain agnostic? Or do we favor one type of technology?

- Scott: We’re technology agnostic, I mean Toyota. We’re going to build the car that the customer wants. That’s our job. Ultimately the market will decide. National policy does choose one technology over another and it ebbs and flows with political cycles.

A Conversation Between the US EPA and CARB on Vehicle GHG Standards and Related Policies
Moderator: Jack Broadbent, Executive Director, BAAQMD
Speakers:

- Richard Corey, Executive Director, CARB
- Chris Grundler, Director, Office of Transportation and Air Quality, US Environmental Protection Agency

Broadbent: With new ozone standards, we need a transformation of the transportation system. How will this work?

- Grundler: These standards are only proposed – not yet final. We need policy innovation and technology innovation. Some regions like Southern California may need their own approaches.

- Corey: 40% of GHG, 80% of NOx, and 95% of diesel particulates come from transportation sector. There have been big improvements but we need to do more. There’s no way around this. We need 90% NOx reduction to get to standard in some places. How did we get to where we are? A series of partnerships with EPA and others, low-carbon fuels standards, in-use fleet changes, new vehicle standards – we need it all. We need to clean up existing fleets; we need cleaner new technologies, etc. Wherever there is an opportunity to get to zero emissions,
we have to get there. Where this isn’t possible, we need to clean these fuels up as much as possible: renewable diesel, biodiesel, etc. Clearly incentives are going to play a role on the light duty side as well as on the heavy-duty side.

Broadbent: There is a concern about a plateau on some of these technologies, particularly on the aero emission side.

- **Grundler:** We think penetration will exceed our predictions, because of technology breakthroughs and incentives. To achieve what we need to achieve, this progress has to continue. There is a debate about willingness to pay but we do not see a plateau. I would not underestimate the value people place on NOT going to a fueling station. This will matter to a meaningful number of buyers. I also want to applaud what California is doing to encourage other states – they are leading the way.

- **Corey:** A neighbor recently got a plug-in electric vehicle purely because it made economic sense. These things are going mainstream. We are moving out of early adopters and into a broader population that is motivated by economics because these vehicles meet their needs. You cannot count on traditional fuel prices – they go up and down, and these vehicles will continue to play a role. The California Energy Commission has played a huge role in supporting hydrogen infrastructure, which is very important. Will start to see fuel cell vehicles in California and also in eastern states. Consumer choice is increasing as well.

Broadbent: Several regions of the state are putting together important State Implementation Plans (SIPs) for air quality. How do you see the carrots and sticks coming together to help us meet our goals?

- **Grundler:** We need an integrated approach where standards and regulations create a level playing field and incentives complement these standards. They cannot/should not be seen as separate.

- **Corey:** History has shown that we tend to meet standards ahead of time and at lower cost than originally thought. There are opportunities to accelerate turnover and incentives can play a role here. Optimal low NOx standard is another example of smart policy, as it signals where we need to go and helps encourage people to move early.

**Question and Answers Session**

**Audience Member:** Today, innovators can add systems to existing new vehicles, but the regulatory credits don’t flow to the companies. Today, for example, Hino gets credit for an efficient hybrid, but an after-market company won’t get credit for a similar technology. Is there a way to share the credits with the suppliers?

- **Grundler:** Automakers will be looking for everything they can find. They are looking for every opportunity to reduce emissions and generate credits.

**Tim Reese, Lightning Hybrids:** Medium and heavy duty vehicles may be on the road for 20 years, but there’s no way to get any credits from CARB or EPA for after-market technologies.

- **Grundler:** You would think there would be a strong market pull for the fuel savings. There is reason to be nervous about how “real” the reductions and credits are. But we need very open minds on how to get all the reductions we can, especially if the standard ratchets down. We don’t have the luxury to wait for vehicle turnover and may need to look at these solutions.

- **Corey:** There has been tremendous success with credits and certification on diesel PM side, but CARB has some concern on NOx. Ultimately we want to see turnover to newer vehicles that are certified to a much cleaner technologies.

Where are mobile refrigeration rules going?

- **Grundler:** This will be important in the EPA Phase 2 heavy-duty fuel standards.

- **Corey:** The standards recognize a need for lower global warming potential refrigerants. If you look at role of refrigerants in mobile sources, there has been a transition to cleaner materials, but we need to push much further. HFCs replacing HCFCs and ODSs. There is an international opportunity to move the needle.

**The Outlook for Clean Transportation: A Private-Public Investment Partnership**

**Moderator:** Andrew Coors, CEO, Steelhead Industries

**Speakers:**
- **Puon Penn**, Executive Vice President, Technology and Venture Banking Group, Wells Fargo Bank
- **John Rhow**, Managing Partner, PPA Solutions
- **Janea Scott**, Commissioner, California Energy Commission
Coors: Do you agree that we’re in the very early stage of this industry?

- **Penn**: Yes. We ran stagecoaches and horse buggies 162 years ago, so we can look at things from a long-term perspective and we’ve seen industries come and go. We really have 30-50 year purviews on transitions and how long they tend to take place. We finance transportation but it isn’t a huge market share.

- **Rhow**: I’m aligned with Proterra and they offer a superior total life cycle cost value proposition. Capital, fueling, and maintenance added together compared to other technologies like diesel or diesel hybrid, the life cycle cost is lower. Then you have to ask what is the technology risk and is it proven? How do we, as an investor, get comfortable taking that risk that what Proterra is saying is true. Then, what is the technology risk? The battery. With ChargePoint the risk is different. It’s a utilization risk—you are tied to how much the stations are being used. That’s a difficult risk for banks to finance. We’re taking a bet on how many cars will actually show up.

- **Scott**: A lot depends on the technologies or fuels you are looking at. Ed Kjaer mentioned the electrical system has been here forever, but it is now a slightly different use. The tech sector is ever evolving and looking at zero emission technologies, but we still have 27 million passenger cars. We can always use innovation and improvement.

Coors: Is now the prime time for investment in clean transportation?

- **Rhow**: Yes. If you can create a paradigm that can accelerate the adoption of these vehicles—a proven procurement paradigm...it’s what solar did. It’s the financing solution that was the demand pool. If you can create a scalable solution the benefits go to whoever invested at that time.

- **Scott**: The time is now and from a state perspective, the goals for climate change, the clean air goals, and the level of transformation required in transportation over the next 30 years or so...now is absolutely the right time. We’re looking for more, faster. With the California Energy Commission investing $100 million each year, we are looking for the sweet spots.

Coors: A consistent theme has been don’t pick winners and policymakers don’t pick great winners. As investors we’re tasked with picking winners. What technologies do you think are the winners in this environment?

- **Penn**: I’m not smart enough to pick the winners, but it doesn’t make sense to say we shouldn’t pick winners. Policy does bet on outcomes anyway. You have to take some bets, and this is a risk business at the end of the day. We’re not geared to take technology risks. Our primary risk assessment is the ability of someone to pay. Someone has to pay in the supply chain. If there’s a market and someone can pay, that’s what we focus on and that tends to keep us out of trouble. The other thing we focus on is gaining insights into customers, and what it is that end-users want at the end of the day. Our role is to try and find entrepreneurs trying to identify a solution. We have access to people to figure out what they are trying to solve, and then we go to our Rolodex to find the right people to build that relationship.

- **Scott**: At CEC, we try not to do that. Assembly Bill 8 directs us to invest in a broad portfolio. The challenge is measuring the progress. Another challenge is that we are always over-subscribed. How do we reach the broadest set of innovators so when we pick, we’re getting the best scalable, problem-solving proposals.

- **Rhow**: CEO’s of the companies would be proponents of creating a bigger pond and creating competition. When Tesla got the Wells Fargo validation, that was a big point for Tesla. $100 million is great, but how do we leverage this? We need a bigger marketplace.

Coors: Where should a private fund fit in the cap table?

- **Penn**: It depends on the risk appetite of that capital fund. There are opportunities everywhere.

- **Rhow**: The venture capital model of betting on winners has a high hurdle rate. You’ll have one winner and ten losers. From my standpoint, our return is in line with infrastructure type of returns. It is long-dated but fully contracted cash flows. What is the cash flow I’m getting associated with the technology, what is the potential risk, and how do I allocate it?

Coors (to Penn): You are active in philanthropy in Cambodia which I’m sure has a very different look and feel than in CA. How transportable are these technologies?

- **Penn**: Those markets are always going to be a bit of a follower, but I see that they are starting to deploy electric buses and natural gas vehicles in Cambodia. The economics for clean technologies in third world countries makes more sense than it does here, because the cost of energy is so much higher. In many markets like Cambodia, India and China, they have the benefit of coming to the party late. They don’t have to worry about...
infrastructure like landlines for telecommunications, or a central generation infrastructure, which made sense a long time ago but manufacturing isn’t a huge part of the economy. Those countries are moving toward more of a distributed energy model so they don’t have the costs of the legacy systems.

Coors (to Scott): What is the role of the CEC in attracting private capital in clean transportation?

- **Scott:** That’s a terrific question. We’ve had a workshop where we look at that. We give $100 million out in grants, and we’re always oversubscribed. I think about leveraging with state and local programs and private capital. We’re looking at the Treasurer’s office with a low-interest loan program. CEC could help put money in that space. We’re targeting small businesses that might want to put a charging station in place, so it would be a low interest loan that they would pay I 10-12 years and then we could invest that in small businesses. AB8 gives us the latitude to think creatively.

- **Rhaw:** The California Energy Commission has been creative in thinking of the principles of where we can take risk. These solutions (first loss reserve) are all credit enhancement solutions to get attractive financing.

**Question and Answers Session**

**Carol Sturman, Sturman Industries:** Are you looking at the administration costs of receiving and spending money and how that impacts smaller companies?

- **Scott:** We do have programs at CEC set up for smaller companies. The flip side is that we’re accountable to taxpayers for what we’ve spent and how we’ve spent it. I can definitely take that back and ask the team if there are streamlining options. We want to be good stewards of the taxpayer dollars.

- **Rhaw:** Take the analogy of a large fish in a small pond. California’s north of 40% of PHEV sales so we’re big fish but in a small pond. All of the policies and engagement has to get out of California if this is going to be real. How do we get other markets engaged? There are 18-20 makes and models available in California today and there are only 3 outside of California. OEMs will take them to other markets but regulations, policies, codes, infrastructure, all of it has to be in place. These other states need to come online to bring costs down and drive volumes. How do we make states other than California succeed?

- **Penn:** I don’t think too hard about what the rest of the world is going to do. There are maybe 60 million people who are still on dial-up. In every market there’s a huge percentage of people who don’t want to change.

- **Rhaw:** It’s happening. California has become the paradigm and it is being studied very carefully. There are a lot of incentives being passed. Atlanta is the highest EV growing city of state.

- **Scott:** There are two projects California Energy Commission has invested in. The Caterpillar hydraulic hybrid has the potential that wherever they use the vehicles they will benefit from CEC investment. Another is the project with the LA Air Force Base to take non-tactical vehicles, bundle them together and see if they can feed energy back to the grid.

**Future of the Grid and Why It Matters for Transportation**

**Moderator:** Mil Ovan, President, Navitas Systems

**Speakers:**

- **Pedro Pizarro,** President, Southern California Edison
- **Pasquale Romano,** CEO, ChargePoint
- **Stephen Berberich,** President and CEO, California Independent System Operator

**Ovan:** By 2024 California will be awash in energy, what will the future grid look like and what role do EVs have?

- **Berberich:** With solar energy coming on the system, by 2024 we expect to see over-generation. In that scenario, we will have to curtail renewables. This is a challenge that is already happening—this year we saw over-generation even though it was a low hydro year. EVs provide great opportunity to absorb all this extra power. Charge at the middle of the day. EVs can help shape demand better.

- **Pizarro:** By delivering power reliably and safely, we are seeing change. Innovations in the marketplace and customer needs and wants.

**Ovan:** How do we reshape what it means to be a utility in today?

- **Pizarro:** By transforming the grid with power flowing in one direction with solar, wind and storage devices, and vehicles that are taking and returning power. It is demand/response ... The grid can optimize these resources and we can get the most bang for the buck.
Ovan: Does a point come out that at some point you don't need the grid?

EPRI provided a report that shows what would it cost for a home to supply its own electricity and it turned out to be three times more expensive then power from the grid.

Ovan: What regulatory changes are required?

- **Romano:** In order to have appropriate deployment there needs to be availability of capital in the marketplace. We currently have 30,000 stations, but need 90,000 for 1 million ZEVs in 2025, but this will require $350 million in capital. We asked the California Public Utilities Commission for action, and phase 1 will include 1500 stations coming on board in mid-2015. SCE is doing a phased rollout proposal for CPUC, and NOT actually owning the charger. The infrastructure would be on a separate meter and EV specific without complicated sub-metering.

Another issue is places with multiple chargers with long dwell time. We need 10 chargers per location and go into disadvantaged communities... School, workplaces, state parks. Behavior also plays a part. We need to make sure we have the right signals and the right pricing to respond to grid needs.

The ChargePoint attachment rate is currently 10% with one port for every 10 cars. To make it pervasive, this needs to be 20-25%. Installation is 50 percent of the cost. The SCE proposal would significantly cut the costs, probably by 50%.

- **Berberich:** CalISO doesn’t think you will get people letting you discharge battery. But if we can modulate charging, you can get much of the grid benefits without even having to get into discharge use case. We don’t need to be able to discharge if we can just manage the amount that is going into the batteries.

If there will be a glut of electricity supply in the middle of the day, can it be opportunistic to use it for port drayage and catenary or other. Electrifying transportation has to part of the equation all in terms of reducing greenhouse gases. Investing in aging infrastructure and smart components this is a way to get better and greater utilization of the grid. We will have a lot of electricity in the state and will have to rethink and reshape how we use it.

- **Romano:** We need to ask our policy makers for investment in the grid. Regulatory constructs have to adapt as well and the pricing to the customer has to better reflect the conditions. Vehicle incentives are important and vehicle economics need to make sense for consumers to buy the vehicles. ChargePoint can put in the entire infrastructure.

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**The Race for Global Leadership in Global Transportation – US-China**

Moderator: **Karen Hamberg**, Vice President, Strategic Energy Futures, Westport Innovations

Speakers:

- **Brendan Riley**, Vice President, Fleet Sales, BYD Motors, Inc.
- **Paul Beach**, President, Octillion Power Systems

Hamberg: Which country will most quickly deploy technology breakthroughs, increased economic competitiveness, and even the silver medal is compelling and attractive. A great report from Accenture in 2012 outlined who has an advantage and why. The goal of both countries is to displace gasoline and reduce petroleum imports. Both countries have significant government and private sector leadership, committed R&D and long-term policy.

There are key differences too. In the US, it is about displacement and in China it is about meeting new demand. In the US, it is on who wins and loses, in China it is about who will be the winners and who will be the bigger winners.

- **Mulder:** Woodward is involved with NG control systems. We make the components, software, and hardware and integrate them into a system that allows an engine to run on LNG or CNG. We’ve been in the business for over 20 years— in the US until 2006, when the OEMs got out of the market (except for Cummins Westport). Woodward has a 100% market share in Korea, but the new market is really China. Woodward works with 8 engine OEMs and we are aggressively expanding market share. This year we will sell 55,000 engine control systems in China (4x more than the US). Woodward even has another US competitor there that has the same number of sales—so it is a huge market. The Chinese market is a good template of what could be in the US.
Riley: Sixty percent of BYD shares are owned by US interests. BYD is a producer of batteries, and we make automobiles, photovoltaic sales, etc. I am in the transportation group at BYD. We produce 450 cars in China every year, which are PHEV and pure electrics. BYD sells 4,000 pure battery electric buses in China annually. In the US, the entire bus market is 5,000 buses. BYD is the largest pure EV manufacturer in the world and we sell 35% of buses consumed here in the US (100 buses).

Beach: The question of how you export the technology in California out of California came up earlier, and that is how we (Octillion) started in Silicon Valley. The concept was making batteries here and exporting them to China. We are taking US know-how and going big into the China EV market. We are working on the first 10,000-battery build for EVs, and we have 1,000 on the road. We are working with OEMs to bring it all together. Octillion wants to bring what we are doing in China back to the US. The US and China will both be winners because there is so much to lose. China is poised to be more aggressive about it.

Hamberg: Westport is headquartered in Vancouver and we engineer vehicles across a range of applications and work with the largest OEMs in the world. We have Cummins Westport and Weichei, which has been one of our most successful revenue streams. I authored their corporate strategic plan. We have gone back and read our analyst reports, and for the first time we saw a number of analysts saying the North American market wasn’t moving as fast as we expected. So, the reports tell the China and global story of how there are significant penetrations in China and Asia and Europe.

Mulder: China doesn’t need to do anything to realize growth. China has set up the infrastructure; fueling stations are there and the supply is there. I don’t know what more they could do to prepare. Contrasted with China, the US is a big mess. Our policies and laws are a hodgepodge. It is a mixed bag of incentives and disincentives. We’ve got huge supplies of natural gas. The most important thing the US could do is put together a cohesive plan of what we could do to use more of it. Today our policy is driven by lobbyists and varying interests. We need to simplify it down to a carbon tax and let the markets play it out.

Hamberg: There are tremendous leading fleets that have made it work: Frito-Lay, UPS, Kroger. The lessons from those fleets will hopefully be translated.

Riley: China is an easy place for us to do business. The government policy is clear: 30% alternatively powered vehicles. I think it is very straightforward and it is like the Wild West doing business there. I always thought China was strict and ordered and I was wrong about that impression. The issues here, and how they affect my business have been mostly policy-related. Besides business hiccups in general and the competitiveness in the US, the problem is that there is no clear policy and deadlines aren’t adhered to.

Beach: You can’t just take a design and product in the US, build it and stick it on a shelf and assume someone will pick it up and buy it. Every single battery, regardless of how close in proximity they might be to one another, is always different on a new platform. If you are manufacturing batteries, you need to work closely with the engineers in that language and that setting. We are a small company, so we had to finesse how to create those duplicative engineering resources and duplicate that in China. Our manufacturing is done in China because it is more cost-effective there. We build a design and give the blueprint to our Chinese counterparts. There are communication issues with that. To work in China you need engineers and a resource application team there to make it work.

Mulder: The only way people will invest is if they know what the plan is, and can rely on it for the future. In the US you can save $30k running on natural gas compared to diesel, but to do so the customer has to invest. If they don’t know that the cost savings will be there in the future, the business can evaporate overnight. China’s plan is distinct and believable making it a much more robust market.

Riley: I would like to echo Paul's (Beach’s) comments. The issue with doing business in China is almost purely cultural. BYD has an overseas group as part of the company, and they are most closely related to marketing. They send people from the US to China and China to US, and they spend 3-6 months in that culture and speak only in Mandarin or Cantonese. We try to go into a market and explore the culture and the inner workings by living there.

Beach: I have a US team interfacing with US customers, and he has select Mandarin speaking engineers who are the conduit. There are no English speakers on the Chinese team. They have to run the communications between the plants in Mandarin. If you don't interact with the engineers there, they forget that you exist. You have to be there every 2-3 months to keep the relationship going.
Mulder: Alcohol is a way to solidify the relationship and that was the key to show that you can be one of us, and you aren’t just here to take money from us. Drink heavily and go there a lot.

Hamberg: With regard to patent protection and intellectual property, what are the challenges and how do you mitigate?

Beach: I've not had any experience with those issues but there’s no win in trying to fight it in court. You can’t ignore intellectual property, because in the US you can enforce it. I have a jaundiced view relating to patents. I think you should find critical areas and patent it, and focus here on enforcement. If you have your property protected in the US, the Chinese will probably not violate your intellectual property.

Mulder: The Chinese culture has a different view of knowledge. In China, the culture is that knowledge is free to share; you can’t own knowledge. They aren’t doing something criminal—it is just a different way of thinking. If you want to do business in China by trying to protect your business model, don’t even go. If it is easily copy-able, it will be copied. We try to keep upgrading and innovating, so if they copy what we did last year that’s fine because we have something new. We’ve had no blatant intellectual property infringement.

Riley: BYD owns a lot of technology and has a lot of patents in China. It comes down to who can build the product better. Copies are looked upon very poorly, so if you make a BYD battery it wouldn’t be accepted. Interestingly, in the Chinese market, I expected a communist regime that controls what you buy and where you buy it. They are very much free market capitalists. The Chinese are natural business people, and they naturally navigate toward the best product. The copies don’t make it that far. They seem to come here and flood our market, but there they are shunned. We’re more concerned with the rest of the world taking our technology.

Mulder: Related to compliance, in China we talk about Euro 5 and real Euro 5. It is common for them to do an emissions calibration and then a performance calibration. In the US, you can certify emissions families. If you certify one engine, it certifies the other one. In China they certify one engine and it can be a complete different engine and they call it good to go. That was the past. In the past year they pulled 10 buses out of fleets and actually checked the emissions and they are enforcing it now. The reason is they just can’t breathe. The government has to fix the air.

Questions and Answers Session
Darren Post, ALTe: ALTe is fighting suppliers, motor controllers and battery manufacturers doing business in the US and China. If you go to New York State to do a bus project and they want all US motors, motor controllers and US batteries. In China they want all Chinese motors, motor controllers and Chinese batteries. How, together, can we grow a footprint in both places?

Beach: My company made the decision to move all production and engineering to China. They said, just grow the business. I told them that can’t happen. I need my own team and production capacity. I’m working on creating a platform so I can do some production in China, and then ship it here and then we finish it here. It is hard for a small business. We're 200 people and most are in China. You have to be creative and pick your battles.