DATE: November 13, 2015

TO: California Air Resources Board

FROM: Ryan Schuchard, Policy Director, CALSTART

RE: Comments on CARB Draft CCI Investment Plan (2016-17 through 2018-19)

Clean Transportation Technologies and Solutions

www.calstart.org

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CALSTART appreciates this opportunity to provide comments on the California Air Resources Board's (CARB) Draft Investment Plan of Cap-and-Trade Auction proceeds for 2016-17 through 2018-19.[1] We have prepared comments which the board may wish to consider. The comments are summarized as:

1. Low Carbon Transportation Requires **Sustained Additional Investment;**
2. Investments Should Support **The Full Arc of Commercialization**—Across Diverse Technologies in Different Stages of Evolution;
3. Targeted **Industry Engagement** Can Enhance Impact; and
4. **Additional Complementary Policies** Will Be Needed.

We applaud CARB's continued leadership on climate change and sustainability, and these comments are a reflection of CALSTART's earnest desire for California to achieve its bold climate change and sustainability goals. The perspectives, analyses, and diagrams included draw from multiple recent research initiatives and discussions with the industry led by CALSTART.

1. Low-Carbon Transportation Requires Significant Additional Investment

Low-carbon transportation is fundamental to California's climate, pollution, sustainability, and economic goals, and therefore the California Climate Investment (CCI) program needs to be investing heavily in low-carbon transportation. Reasons why this sector transportation deserves significant investment include:

- Transportation is responsible for nearly half of state GHG emissions, and mobile sources are the largest source of criteria emissions;
- The single largest contributor to CCI funding is gasoline and diesel, making Low-Carbon Transportation the most direct way to cut oil and use and grow low carbon fuels;
- Governor Brown has committed California to reduce petroleum use 50% by 2030, which requires a doubling of speed that will require significantly more resources;
- Of all of the proposed areas of investment in the three-year plan, Low Carbon Transportation will have the most significant benefits in terms of reducing criteria emissions and improving public health. Correspondingly, Low carbon

transportation investments can be targeted to benefit Disadvantaged Communities (DAC).

The increased level of investment in Low Carbon Transportation per the Governor's May 2015-16 budget was in line with what was needed for this current fiscal year. Looking ahead, recognizing that the federal government is not likely to increase its financial support for the transition of many of these technologies, we are recommending that the funding for this sector be increased over the 2016/2017 to 2018/19 budget years. As outlined in the draft investment plan (p. 32), many obstacles stand in the way of faster deployment for low-carbon transportation, including insufficient levels of rebates for ZEVs and PHEVs, consumer adoption of ZEVs among broader communities including small businesses, financial support for ZEV freight systems, and funding for alternative renewable fuels and infrastructure.

We believe that CCI **funding for low-carbon transportation needs to grow to at least $500-600 Million in 2016-17, and then $600-700 Million in 2017-18 and $700-800 Million in 2018-19.** This is additional to the investment programs reauthorized by AB 8 aimed at driving technology development and adoption. Figure 1 provides illustrative preliminary budget amounts by key program area.

Furthermore, it is important that consistency and stability for these investment programs to be enhanced. A continuous allocation for the levels outlined is needed to providing confidence to lead manufacturers to make multi-year investments in new commercialization as is required.

Figure 1. Illustrative Budget by Key Program Area

Funding Categories	FY 2016-2017	FY2017-18	FY2018-19
Zero Emissions Vehicles (ZEVs)	$250M	$300M	$400M
ZEV Purchase Incentives - DACs	$25M	$30M	$35M
Zero Emission Buses	$60M	$70M	$80M
Adv. Zero- Emission Truck & Off-Road Veh. Dev & Demo.	$75M	$75M	$65M
Ultra Low NOx/Low Carbon M-HDV's	$15M	$20M	$25M
HVIP – Adv. Truck Purchase Incentives	$25M	$35M	$45M
Low Carbon Fuel Production Facility Investments	$50M	$75M	$100M
Total	**$500M**	**$605M**	**$750M**

2. Investments Should Support The Full Arc of Commercialization—Across Diverse Technologies in Different Stages of Evolution

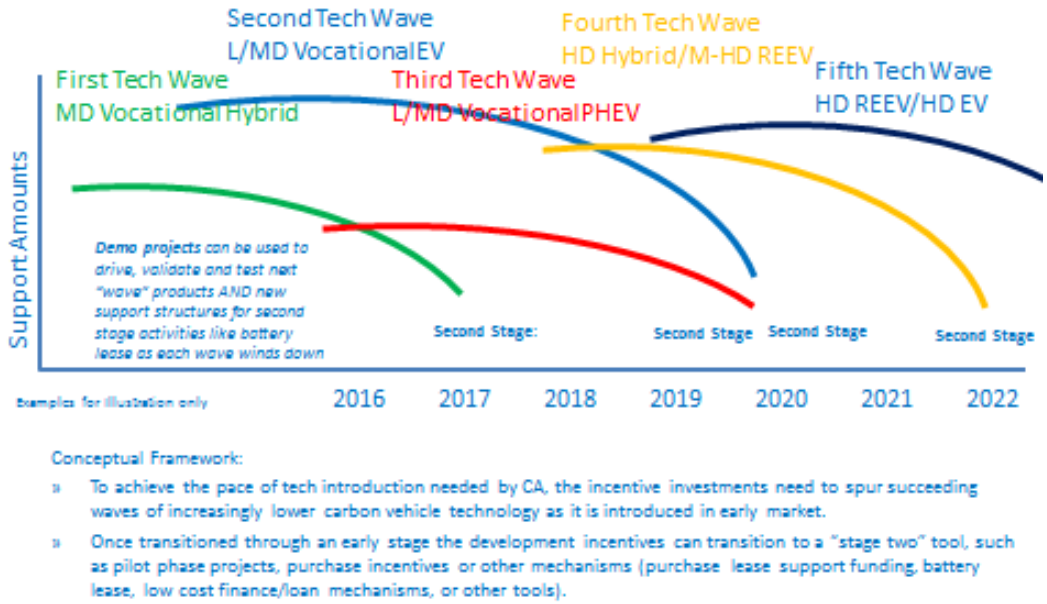
As a guiding approach for the investment program, CCI should promote the use of incentives that connect activities throughout whole arcs of product development and commercialization in targeted ways, and then level off and decline after (but not before) technologies become sufficiently mature. Providing sustained funding over the full commercialization phase will increase the chances of success for Low carbon Transportation with maximum impact across diverse vehicle uses and populations.

Vehicle technologies move through sequential stages from concept development to commercial production. A successful progression through developmental stages requires funding support at each stage. Typical stages of development and support required at each stage include:

- **Studies and Standards:** Perform studies on advanced tech business case and tech feasibility; Develop standards as needed. *Examples: Charging standards; Business case for ZE trucks*
- **Technology Development:** Develop components, subsystems, and complex drivetrain systems, with focus on performance improvements and cost reduction. *Examples: Advanced engines such as opposed-pistons; Enabling technologies such as lightweight storage tanks*
- **Small Early-Stage Demos:** Integrate new truck and bus tech into 1-5 vehicles to evaluate tech performance and integration and to identify needed improvements. *Examples: Zero-emission "big rig" trucks for short haul; Optimized alt fuel engines*
- **Larger Pre-Commercial Demos.** Support for larger scale deployments of up to 50 vehicles to evaluate real world performance in the field at commercial scale. *Examples: Zero-emission buses and trucks for short haul applications*
- **Early Commercial Deployment:** Long-term vehicle buy-down incentive programs to increase market penetration; fuel infrastructure funding tied to vehicle incentives. *Examples: Deployment incentives for hybrid, electric, and NG trucks*

This "Full Commercialization Arc" framework ensures that investments are not isolated but instead connected to a steady march of development, and it provides a means for continuously developing new technologies (See Figure 2).

Figure 2. Rolling, Overlapping Technology Development and Incentive Funding Waves: Conceptual Framework



Conceptual Framework:

- To achieve the pace of tech introduction needed by CA, the incentive investments need to spur succeeding waves of increasingly lower carbon vehicle technology as it is introduced in early market.
- Once transitioned through an early stage the development incentives can transition to a "stage two" tool, such as pilot phase projects, purchase incentives or other mechanisms (purchase lease support funding, battery lease, low cost finance/loan mechanisms, or other tools).

For example, the Zero Emissions bus (ZEB) sector has progressed through the different phases and is now reached early commercial deployment. Further incentives are needed until ZEBs reach a point of ~10% of new sales, at which point they could start declining. (See buses in next section.) Other advanced ZE truck segments that are not as far along need to go thru that same commercialization process for 2-3 key ZE truck segments.

Furthermore, incentive funding should encourage incentives that are performance-based, with higher reward for higher impact across multiple criteria, and it should develop "ecosystems" that create network effects and new saturation points in key regions and technology/market settings.

3. Targeted Industry Engagement Can Enhance Impact

We support the major categories proposed for investment (p. 33), which include Advanced Vehicle Technology, Alternative Fuels and Infrastructure, System Efficiencies, Sustainable Communities and Transportation Infrastructure. To maximize impact, we propose that investments in these areas encourage targeted engagement as described in the following sections.

Medium and Heavy Duty Vehicles—Trucks

Although trucks are only 5% of the California vehicle fleet, they are responsible for 23% of vehicle greenhouse gas emissions. One-third of all NOx emissions in California are from trucks. Progress in trucks has been slow, particularly goods movement trucks such as drayage. Few truck manufacturers are taking the ZE market seriously, meaning development and prototype demonstrations are dominated by small technology

developers. ZE truck capability is still in the development stage and needs to progress intelligently—though rapidly—to achieve the necessary early market deployment.

One reason that truck classes and applications are diverse, and there are no silver bullet technologies (See Figure 3). Meeting 2030 and 2050 goals for this sector will require a portfolio approach with meaningful contributions from increasingly efficient vehicles running on increasingly de-carbonized liquid and gaseous fuels.

Figure 3. Highest-Feasibility Areas of Technology Development

Pathway	Technology	Class 7-8 Urban	Class 8 OTR	C 3 – 8 Work Site	Class 3 – 8 Urban	Class 3 – 8 Rural	Class 2b – 3 Vans/ trucks
Electrification	Hybrid Electric	●	◑	●	●	●	●
	Electrified Auxiliaries	●	●	●	●	◑	●
	E-Trucks	●	○	◑	●	◑	◑
	Electric Power Take-off	○	○	●	○	○	○
	Plug-in Hybrids	●	○	●	●	●	●
	Electrified Corridor	●	○	○	◑	○	○
	AF Hybrid	●	◑	◑	●	●	◑
Engine and Driveline	Hydraulic Hybrid	◑	○	○	●	●	●
	Optimized AF Engine	●	●	●	●	●	●
	Waste Heat Recovery	●	●	○	●	◑	◑
	Engine Optimization	●	●	●	●	●	●
	Alternative Power Plants & Combustion Cycles	●	●	◑	◑	◑	◑
	Transmission and Driveline	●	●	●	●	●	●

The 13 technology strategies deemed most feasible by the CalHEAT research are shown in this chart. Solid circles represent the technologies in the Roadmap that are expected to contribute to noticeable CO_2e reductions by 2020. Half circles represent technologies expected to be implementable after 2020 with noticeable results. The empty circles indicate technologies not expected to offer significant results in that truck category.

California Hybrid, Efficient and Advanced Truck Center Research

In the near-term, zero emission repowers or remanufactured vehicles can assist to bring down the cost of zero emission technologies. We think the state should be open to these solutions and should provide incentives for them.

Over the medium term, range extenders or dual mode hybrids need more attention. These vehicles could run zero emission in highly impacted regions but have the ability to travel longer distances by using a natural gas, diesel, or fuel cell range extender outside of those areas. We are hearing a lot of interest from fleets and an openness from manufacturers to investing in this technology, but there are no commercially available options today.

Recommendations for longer term development include the following:

Involve OEM truck or chassis makers at the earliest stage possible. Recognize the longer lead times and deliberate process they follow to develop and manufacture a product that they believe they can sell and support. Structure development programs around the end goal and recognize where in the stage of development a technology product currently lies. Structure multi-year efforts to help fund OEMs and suppliers

through the development process that leads to a final product. And do not neglect market development and fleet engagement activities to help build confidence in a future market for the products.

Actively guide and assist small and early stage innovators to achieve success. This will involve brokering and supporting partnerships with OEMs and chassis makers. It requires encouraging small companies using OEM chassis to get direct engineering support to integrate their systems effectively into the OEM platform, as well as encouraging small and innovative companies to develop or move towards a QVM (Qualified Vehicle Manufacturer) relationship with the OEM or with a partner who has such capability. This will make it easier for the OEM to provide warranties and technical assistance.

Furthermore, it will be helpful to encourage and help fund small companies to outline and engage in engineering cost studies and processes to identify how to engineer cost out of their system and to design their systems for manufacturability. This support can be built into project activities. It will also help small companies and OEMs to devote some CCI resources to identify and develop supply chains for critical components.

Finally, it will be helpful to encourage and fund small companies to develop their market entry plan and pathways, including providing adequate field service and support as these have proven to be failure points in the past.

Medium and Heavy Duty Vehicles—Buses

Although a far smaller share of the medium and heavy duty market, buses have progressed much faster than trucks in general. Zero emission (ZE) buses are now moving out of development and into extremely low volume, high-cost early deployments (See Figure 4). Buses are vitally important to medium/heavy duty sector overall, because it is the spearhead of technology development. Therefore progress in the bus category is instrumental to advancement for goods movement. Their success in the marketplace, as well as the network of initial infrastructure they will require, will directly support transitioning the technology into the truck arena.

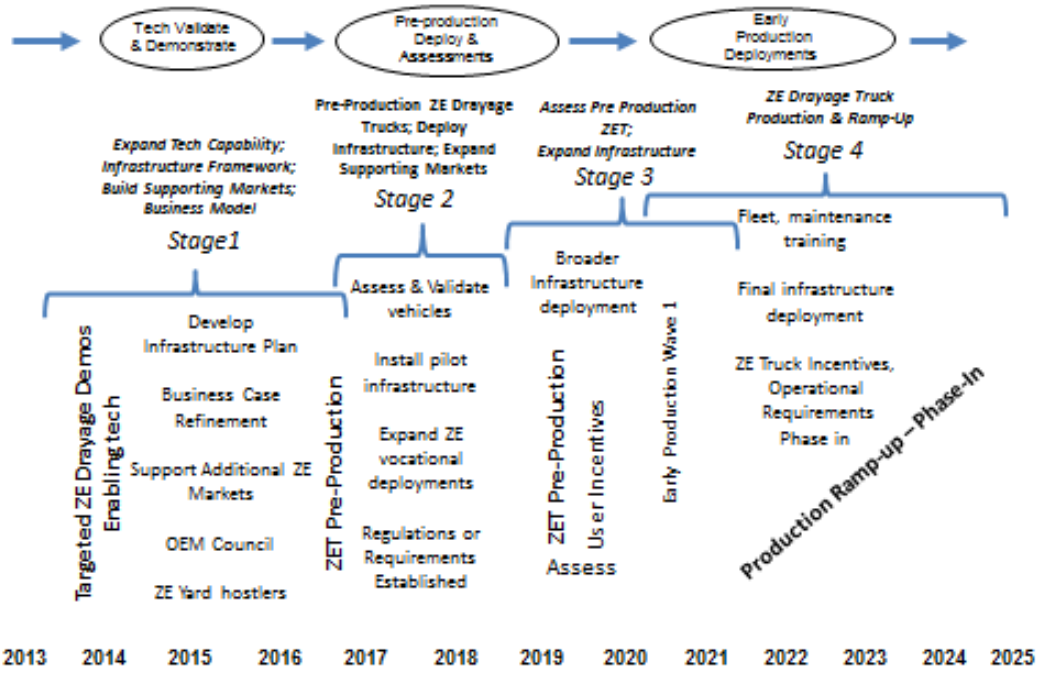
Buses have been the early introduction platform for natural gas engines and hybrid systems, and are now poised to serve this same role for zero emission technologies. Consistent, long term funding to quickly and steadily expand the ZE bus market and acceptance has its own early benefits to communities, and provides a medium-term benefit to bringing drive systems to maturity for transition to trucks.

That said, the broader marketplace for ZE heavy-duty vehicles is still thin and the supply chain is exceptionally weak. None of these vehicles can come to market in a vacuum, nor will a “support all-comers” approach to developing and funding projects move the market forward as desired. While encouraging and supporting the state’s tech innovators, it is also essential that the major truck original equipment manufacturers (OEMs) are brought into the development process as soon as possible and convinced of the commitment being made by the state and key stakeholders.

It is crucial that current early stage developers be guided to more commercially-viable designs and development stages. It is possible to focus all funding on technologies representing the final solution today (fully ZE trucks; 100% zero emission miles).

However, a flaw in that approach is the reality of product development – there are essential technical and product stages that need to be passed through first to reach the end goal of producing a commercially-acceptable 100% ZE truck. Recognizing and supporting this reality will improve OEM support and encourage their involvement, and better prepare the industry to produce fully ZE trucks in the near future that will meet fleet user needs.

Figure 4. Interstate 710 Zero-Emissions Drayage Truck Commercialization and Phase-in Process



Additionally, a more structured and organized approach to commercialization is needed. This should be based on operating from knowledge of the gaps in technology development, honesty about the weak structures of potential product developers, and understanding the well-proven staged – or "gated" – development frameworks used by OEMs. With such an approach, projects with a better potential for ultimate success can be assembled and small or early stage innovators can better be supported and provided assistance. .

Light Duty Vehicles

California is leading the nation in terms of light-duty zero emission vehicle (ZEV) sales. However, the car companies are only providing zero emission options for a relatively small number of models and types of vehicles. Fuel cell vehicles are just now being introduced to the market and will need incentives to help jump-start that market as well. Consequently, we recommend sustaining current levels of annual vehicle incentive until 2020. At that point we anticipate that battery costs will have declined enough that incentive levels and incentive levels can start to decline.

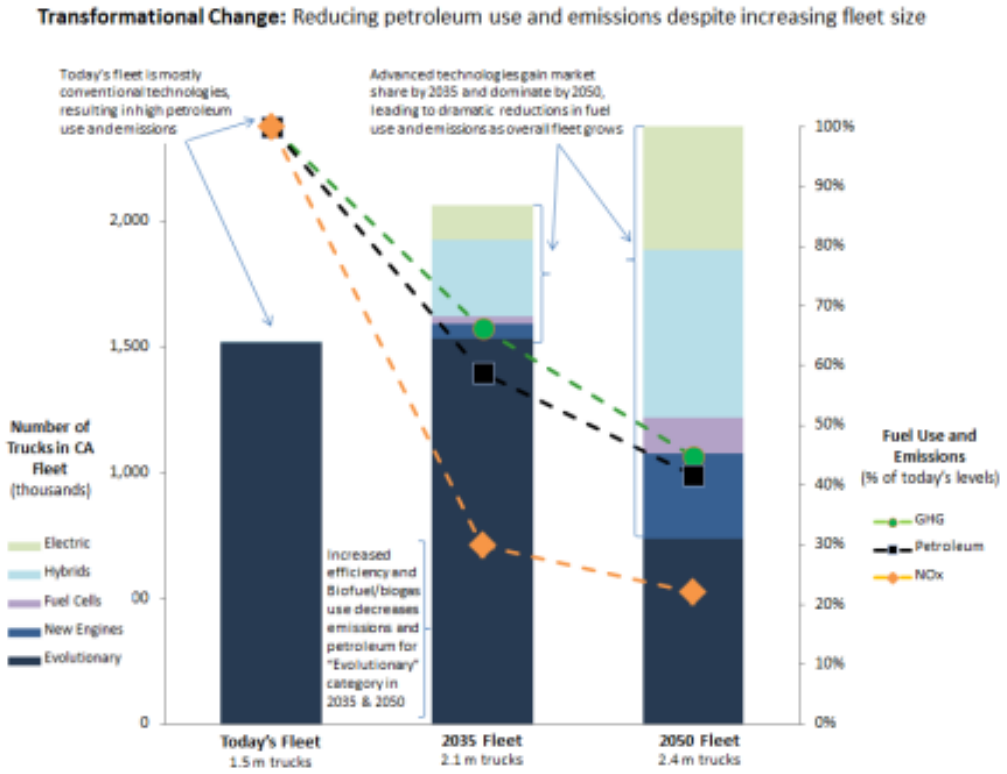
As an alternative to the existing consumer rebate, the legislature and the Governor may want to consider waiving the state sales tax on zero emission vehicles. Such a measure would be roughly equivalent to the incentives provided today by the use of CCI funds.

If the legislature and Governor were to move in this direction, it would most likely to still be necessary to provide CCI funding to incentivize the purchase of new or used electric vehicles in disadvantaged communities and by people with lower incomes. Additionally, it may also be advisable to provide a small amount of CCI funds to provide a smaller incentive level for new car dealers.

Fuels and Fueling Infrastructure

Investment in vehicle technologies is critical, but not sufficient, for achieving low-carbon and clean transportation goals; more directed investments are needed in fuels and fueling infrastructure. To be sure, California needs to stay the course on the Low Carbon Fuel Standard, which is vital for directing new supplies in the fuel pool used in California. But increased investments are needed to encourage investment and production in the state and to increase volumes of low-carbon fuel. To do this, we need to broadly support multiple fuels both because different fuels are suitable for different applications, and technologies are emergent. Figure 5 provides an example of the importance of diversity in fuel pathways.

Figure 5. Transformational Change: Reducing Petroleum Use and Emissions Despite Increasing Fleet Size



This includes investment in biofuel and renewable fuel, which is essential for meeting long-term goals in the truck and bus sector. Broadly this includes biodiesel, renewable diesel, biogas (also known as renewable natural gas), and lesser-known options such as dimethyl ether (DME). Clean fuel investment needs vary by fuel type, but include funding for production facilities, distribution infrastructure, and fueling infrastructure.

It also includes enabling electricity as a fuel. The state's goals require dramatic expansion of charging infrastructure to 50,000 public charge points and 1,000,000 total charge points by 2023 to support growth of 1.5 Million ZEVs by 2025.[2] Infrastructure will need to further grow to support growth of ZEVs and PHEVs to 6-7 million by 2030.[3] We need to address infrastructure readiness, costs and utility demand charges through a mix of incentive funding and collaboration between agencies.

None of these technology areas are silver bullets, and additional subsectors must be involved. However, based on current technology trends and policy commitments, these areas are especially important and worthy of expanded focus for the CCI. Fuels and fueling infrastructure (including electricity and charging infrastructure) require significantly more attention within the CCI program.

Technology Buyers and Users

In addition to engaging with the producers of vehicle and fuel technologies, the buyers and users of those technologies are vital to their successful deployment. In particular, fleets need to progress through "stepping stones" that allow market acceptance of products at intermediate stages. As part of this, suppliers and fleets need to work through sequential stages and field experience to prove technology readiness and reliability before large-scale deployments can start.

More specifically, private and public sector fleet managers need vehicles that can reliably meet operational needs, and they have ideally wanted a payback period of just 2-3 years on advanced technologies. Experiences to date with hybrid and zero emission technologies have been mixed in this regard. We have spoken with a number of major fleets through our e-truck task force who have had issues with very early-production product around cost, reliability, lack of available products, and higher than expected infrastructure costs. Low fuel costs and increasingly efficient conventional vehicles make demonstrating a good business case a moving target for some of these technologies. This underscores the need for investments in programs that provide a mixture of incentives, education, and useful insights to users in support of adopting technologies at different stages. More effective use of Low Carbon Fuel Standard (LCFS) credits for all fuels, particularly electricity, could also provide users with highly tangible business case benefits to help make the case for adoption.

4. Additional Complementary Policies Will Be Needed

Increased investment funding that is effectively directed is vital, but not sufficient. Additional policies are important to enable success of the program. These include:

- **Certification procedures.** CARB has recently launched an effort to create streamlined certification procedures for innovative new technologies. This is

vitally important as certification hurdles are unintentionally slowing or keeping some promising technologies out of the market.

- **Regulatory backstop.** We will also likely need to see a regulatory backstop or other clear, long lead-time requirements signals; this is beyond anything the new heavy duty phase two rule will do, especially when it comes to California's dual priorities of concurrent greenhouse gas and criteria emission reductions.
- **Continued flexibility**. Because these technologies are often developed by smaller companies, it will be important to ensure that ARB certification requirements do not create barriers to the innovation we need. We are seeing progress on this front and need to remain open to new approaches and aftermarket solutions.
- **Performance standards.** Industry and investors need certainty about where state policy is headed. Targets for vehicle efficiency, greenhouse gas reductions, and petroleum reduction can help drive investment. The discussion document also contains mention of several additional regulatory levers that could potentially help drive change. Industry needs clear signals of the seriousness of intent and
- **Operating standards.** With the emphasis on zero-emission outcomes, establishing the charging standards and protocols are desperately needed for heavy vehicles and their large energy storage.
- **Price signals.** Given potential sustained low oil prices, we may need incentives to be sustained thru 2021/22. Many prominent economists have called for a carbon tax and dividend (returning all of the money to the public), for example.

Conclusions

We need to see a long-term commitment to significantly expanded public incentive funding for research, development, demonstration, and deployment—and done in a way that considers effort as a "marathon," not a "sprint." We are in the midst of decade-and-a-half effort to cut petroleum use and a 35-year battle to deeply cut greenhouse gas emissions. The product and technology development pipeline must be kept continually active bringing the next wave of needed reductions to the road. We are seeing some of the early results of the state shaping a long-term, coordinated and coherent approach. Nonetheless, advanced technologies for trucks and buses lag far behind cars, and we need to be prepared for a long term commitment, be ready for some stumbles and shake-outs, and plan to adapt and stay the long term course.

At the same time, the next decade will come quickly, and with long term commitments in place, we will see major transitions start to happen soon. If the state can sustain a strong level of investment over the next decade, we can really make a big difference and have a good chance of succeeding, and California doing even more to lead the world.

Resources

CALSTART (2015). Electric Truck & Bus Grid Integration: Opportunities, Challenges & Recommendations. http://www.calstart.org/Libraries/Publications/Electric_Truck_Bus_Grid_Integration_Opportunities_Challenges_Recommendations.sflb.ashx

CALSTART (2013). California Hybrid, Efficient, and Advanced Truck (CalHEAT) Research Center: Research and Market Transformation Roadmap for Medium- and Heavy-Duty Trucks. http://www.calstart.org/Libraries/CalHEAT_2013_Documents_Presentations/CalHEAT_Roadmap_Final_Draft_Rev_7.sflb.ashx

CALSTART (2013). Technologies, Challenges, and Opportunities: I-710 Zero-Emission Freight Corridor Vehicle Systems. http://www.calstart.org/Libraries/I-710_Project/Technologies_Challenges_and_Opportunities_I-710_Zero-Emission_Freight_Corridor_Vehicle_Systems.sflb.ashx

CALSTART (2013). I-710 Project Zero-Emission Truck Commercialization Study Final Report. http://www.calstart.org/Libraries/I-710_Project/I-710_Project_Zero-Emission_Truck_Commercialization_Study_Final_Report.sflb.ashx

CALSTART (2010). Speeding High Efficiency Truck Adoption: Recommended Policies, Incentives and Investments. http://www.calstart.org/Libraries/Publications/Speeding_High-Efficiency_Truck_Adoption.sflb.ashx

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[1] California Air Resources Board (October 2015). Cap-and-Trade Auction Proceeds Second Investment Plan. Available at http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/investmentplan.htm.

[2] Based on goals for Governor Brown's Executive Order, "2013 ZEV Action Plan." See http://www.energy.ca.gov/2014publications/CEC-600-2014-003/CEC-600-2014-003.pdf

[3] E3 (April 2015). Summary of the California State Agencies' PATHWAYS Project: Long-term Greenhouse Gas Reduction Scenarios http://www.arb.ca.gov/html/fact_sheets/e3_2030scenarios.pdf