Presentation Summary

- Short overview of CALSTART
- Clean truck and bus incentive programs
- California Market Projection
- Global beachhead strategy
- Overview of product coming to market
- Beyond the truck – other areas to address
### CALSTART Overarching Goal:
*Clean air for all; prevent climate change; clean transportation tech industry dominates*
*Speed commercialization of clean transportation technologies*

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**These are our focus areas:**

**This is the work we do:**

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<tr>
<th>Activities Areas</th>
<th>CARS</th>
<th>BUSES</th>
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Investors See Real Opportunities - CALSTART Investor Council (CIC)
CALSTART Worked with the Air Resources Board to Establish an Innovative Clean Truck and Bus Purchase Incentive Program

Governor Brown at event announcing nation’s largest electric truck fleet – July 2012
CALSTART is Managing Clean Vehicle Purchase Incentive Programs in 3 States
Inflection Point for Zero Emission Medium- and Heavy-Duty Vehicles?

Projected Demand for Incentive Funding in California

Based on HVIP projections, interviews with manufacturers and fleets and CALSTART industry research
CALSTART Providing Technical Support Developing CARB 3-Year M/HD Investment Plan

- Strategy for targeted key M/HD investments to drive transformation of M/HD transportation
- Built around concept of tech “Beachheads”

https://www.arb.ca.gov/msprog/aqip/fundplan/proposed_1718_funding_plan_final.pdf
Strategic Transformation
“Beach Head” Framework

• Identify and leverage key early markets where technology can be successful; use as launching point to then support additional applications

• Success comes from growth of core supply chain, transferring similar powertrain and components

• Beachheads help establish first success cases
  – As technologies mature, they can expand in application and get more affordable

• Each succeeding market builds greater volume
Example: Beachhead Market leads to Additional Applications and Larger Markets

Steadily build volumes and infrastructure, business case, performance confidence

Similar drivetrain and component sizing can scale to early near applications

Expanded supply chain capabilities, price reductions enable additional applications
M-HDV Zero Emission Beachhead, Pathways

BEACHHEAD
BEV Transit Bus
BEV Delivery
FCEV Transit Bus
BEV Hostlers
FC Range Extenders
BEV Shuttle, School Bus

Series Drive Engine and FC Range Extender Tech Demos
BEV & BEV XR* M/HD Delivery
EV, PHEV & EV XR* Regional HD

Electrification at Terminals, Facilities
EV & EV XO** CHE

**XO = Extended Operations with FC or engine

2017 Steadily Expanding Climate ‘Wedges” of Increasing Volume, Impact

*XR = Extended Range with FC or engine

Electrification at Terminals, Facilities
EV, PHEV & EV XR* Drayage
REGIONS WITH POTENTIAL FOR CONCURRENT BEACHHEAD LAUNCHES

DRIVING GLOBAL VOLUMES FOR COMMON SUPPLY CHAIN, PRODUCTS
Major Canadian Retailer Going Electric

Loblaw, food and pharmacy company, launches BYD Class 8 truck as start of shift to 100% electric truck fleet.
100% Organic Cotton in Product – 100% Zero Emission Delivery
Cummins Electrified Powertrain

- Class 6-8 delivery, transit bus
- All-electric, downsized engines PHEV and range-extender architecture
Toyota Fuel Cell Truck Demo
Volvo Electric Trucks

- On road in Europe 2019
- Builds off core bus electric powertrain
- Medium duty, distribution trucks to start
- Signaled plans to enter North American market
• 250 kw electric motor, no gearbox
• All-electric auxiliaries (steering, compressors, HVAC)
• Lithium ion batteries from VW Group packaged over front axle
• 200 km/120 mile range
• Pilot production 2017/18; series production 2021
Meritor Electric Axle

- Multiple components built around electric drive integrated into axles – no drive shaft
- Range of size and application designs including low floor bus and line haul
- Also electric suspensions, new air brakes
- CEO Jay Craig: “You’re seeing part of the Renaissance of Meritor”
Real Today: EV Terminal Tractors

- All electric yard tractors in market now from Orange, BYD, Hoist, others
- Up to 80,000 pound loads, up to 20 hour work days
Micro-Grids and Scaling of Fleets – Solar/Storage Synergy
Peak loads for Various Electric Vehicle Fleets (without mitigating grid impacts)

Assumptions: the Chevy Volt charging rate is 3.3 kW, the medium-duty E-Truck charging rate is 15 kW and the E-Bus charging rate is 60 kW.
Understanding How Peak Demand Charges Effect the Business Case

- CALSTART report reviewed 26 major electric utilities in Arizona, California, Colorado, Florida, Georgia, Illinois, New York, Oregon, Texas & Washington
  - 21 out of the 26 electric utilities reviewed levy demand charges
- Demand charges vary widely from $0.00/kW to $23.65/kW
- Time-Of-Use (TOU) rates, demand charges can go up to $59.24/kW
- Highest demand charges are California and New York
CALSTART leading industry effort to get CPUC policy right –
Allowing Utilities to be Partners & Improving Rate Structures
I-710 ZE Commercialization Study
ZE Truck Only Lane – Serving Ports

Significant component and system overlap with transit industry, regional/last mile delivery and military vehicle tech; also connected/automated tech

Tech Options:

- Road Connected Power
- Full Battery Electric
- Dual-Mode Hybrid (w/ ZE mode)
- Series Electric/Range Extender
- Near-ZE NG Engines
New Natural Gas Engine 90% Fewer NOx Emissions

Get Closer to Zero
12 Liter Low NOx NG Engine – Available in Q4 2018
Dairies Generate 40% of California’s Methane Emissions -
CA Company – Using Dairy Waste Material – Will Begin Producing Renewable Natural Gas Next Year – 70 cents/diesel gallon equivalent

Biorem Energy has created a cooperative to

- Reduce Fuel costs to less than 10% of operating costs
- Increase company profits by an estimated 25%
CA Climate Action Summit –
September 12-14, 2018
San Francisco
John Boesel
President and CEO
(626) 744-5607
Email: jboesel@calstart.org