CLEAN FUELS PROGRAM ADVISORY GROUP AGENDA
JANUARY 31, 2018, 9:00 AM – 3:30 PM
Conference Room GB
21865 Copley Drive
Diamond Bar, CA 91765

Call-in number: 909-396-3837

	Welcome & Overview - 9:00 – 10:00 AM	
(a)	Welcome & Introductions	Matt Miyasato Deputy Executive Officer
(b)	Goals for the day *Staff will provide goals for the Clean Fuels Program Advisory Committee meeting and overview of current and planned projects.*	Naveen Berry Technology Demonstration Manager
(c)	Incentive Programs Update *Staff will provide an update on recent legislative activities and their impacts on the incentive programs.*	Fred Minassian Assistant Deputy Executive Officer
(d)	Feedback and Discussion	All
	Areas of SCAQMD Focus	
1.	**Heavy-Duty Technologies - 10:00 AM – 12:00 PM**	
(a)	Heavy-Duty Zero Emission Truck Project *Staff will provide an overview of drayage trucks with all electric and fuel cell operation*	Joe Impullitti Program Supervisor
(b)	In-Use Emissions Testing *Staff will provide an update on the studies initiated by WVU and UCR*	Adewale Oshinuga Program Supervisor
(c)	Heavy-Duty Engines *Staff will provide an update on progress with gaseous and liquid-fueled heavy-duty engines*	Joseph Lopat Air Quality Specialist
(d)	Medium-Duty Zero-Emission Vehicles *Staff will provide a status of projects with all electric and fuel cell operations*	Seungbum Ha Air Quality Specialist
(e)	Renewable Fuels *Staff will provide a status of renewable natural gas and renewable diesel production and use*	Phil Barroca Air Quality Specialist
(f)	Feedback and Discussion	All
	Lunch 12:00 - 1:00 PM	
2.	**Light-Duty Technologies/Infrastructure 1:00 – 2:30 PM**	
(a)	Commercial Fuel Cell and Battery Electric Vehicles *Staff will provide an overview of currently available and anticipated fuel cell and battery electric vehicles and incentives.*	Lisa Mirisola Program Supervisor
(b)	Hydrogen and Electric Vehicle Charging *Staff will present information on statewide and local efforts on retail hydrogen refueling stations and electric vehicle charging*	Patricia Kwon Air Quality Specialist
(c)	Enhanced Fleet Modernization Program (EFMP) *Staff will provide an overview of the implementation of the EFMP program*	Lori Berard Air Quality Specialist
(d)	Feedback and Discussion	All
	Break 2:30 – 2:45	

3.	Wrap-up – 2:45 – 3:30 PM	
(a)	Discussion & Wrap-up *Staff will present the proposed Plan update and information on the 2017 Annual Report and invite input from the Advisory Group.*	Naveen Berry Technology Demonstration Manager
(b)	Advisor and Expert Comments	All

Other Business
Any member of the committee, or its staff, on his or her own initiative or in response to questions posed by the public, may ask a question for clarification; may make a brief announcement or report on his or her own activities, provide a reference to staff regarding factual information, request staff to report back at a subsequent meeting concerning any matter, or may take action to direct staff to place a matter of business on a future agenda. (Government Code Section 54954.2)

Public Comment *Members of the public may address this body concerning any agenda item before or during consideration of that item (Govt. Code Section 54954.3). All agendas for regular meetings are posted at District Headquarters, 21865 Copley Drive, Diamond Bar, California, at least 72 hours in advance of a regular meeting. At the end of the regular meeting agenda, an opportunity is also provided for the public to speak on any subject within this body's authority. Speakers may be limited to three (3) minutes each.*

Document Availability
All documents (1) constituting non-exempt public records; (ii) relating to an item on the agenda for a regular meeting; and (iii) having been distributed to at least a majority of the Advisory Group after the agenda is posted, are available prior to the meeting for public review at the South Coast Air Quality Management District Public Information Center, 21865 Copley Drive, Diamond Bar, CA 91765.

Americans with Disabilities Act
The agenda and documents in the agenda packet will be made available, upon request, in appropriate alternative formats to assist persons with a disability. Disability-related accommodations will also be made available to allow participation in the meeting. Any accommodations must be requested as soon as practicable. Requests will be accommodated to the extent feasible. Please contact Donna Vernon at 909-396-3097 from 7:00 a.m. to 5:30 p.m., Tuesday through Friday, or send the request to dvernon@aqmd.gov.

Science & Technology Advancement

Advisory Committee

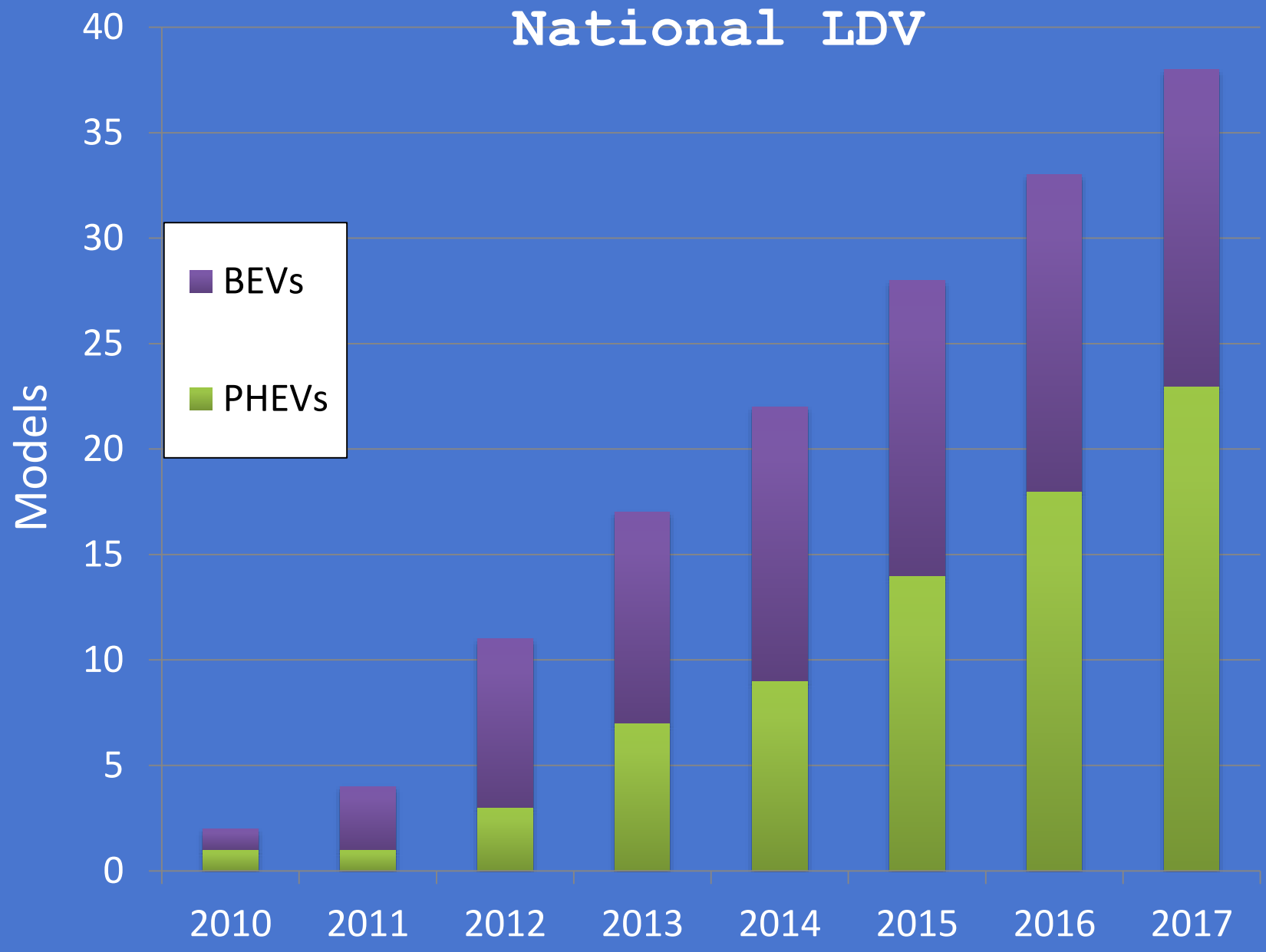
January 31, 2018

Matt Miyasato, Ph.D.
Deputy Executive Officer

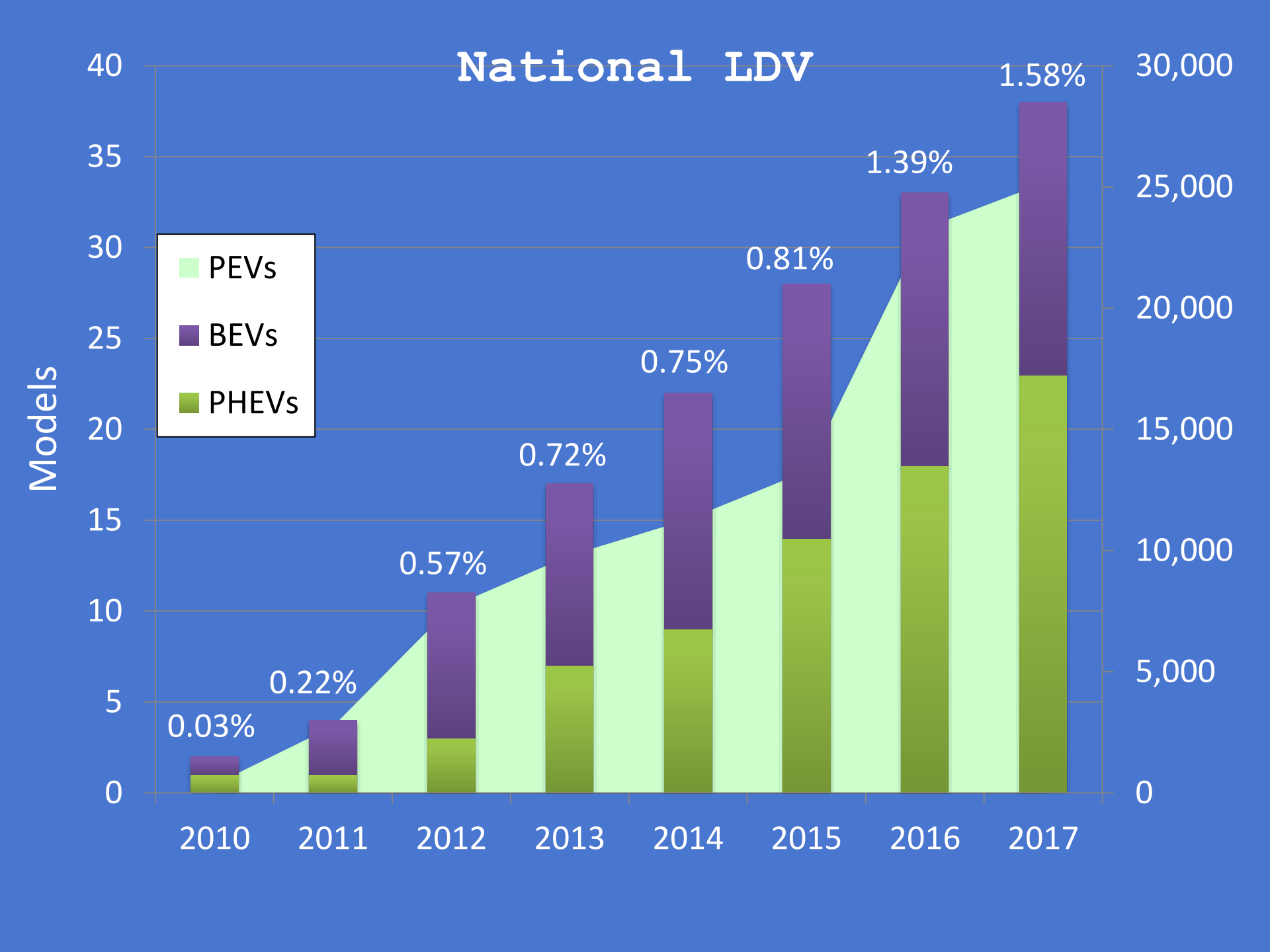

YBRID SPRINTER
Plug-In Technology


EnergyCS
delta-q

Ryder signs exclusive deal with L.A. electric-truck maker Chanje



2005 – 2007: SCAQMD Prius and Escape demos


National LDV
Models
PEVs
BEVs
PHEVs
0.03%
0.22%
0.57%
0.72%
0.75%
0.81%
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2010
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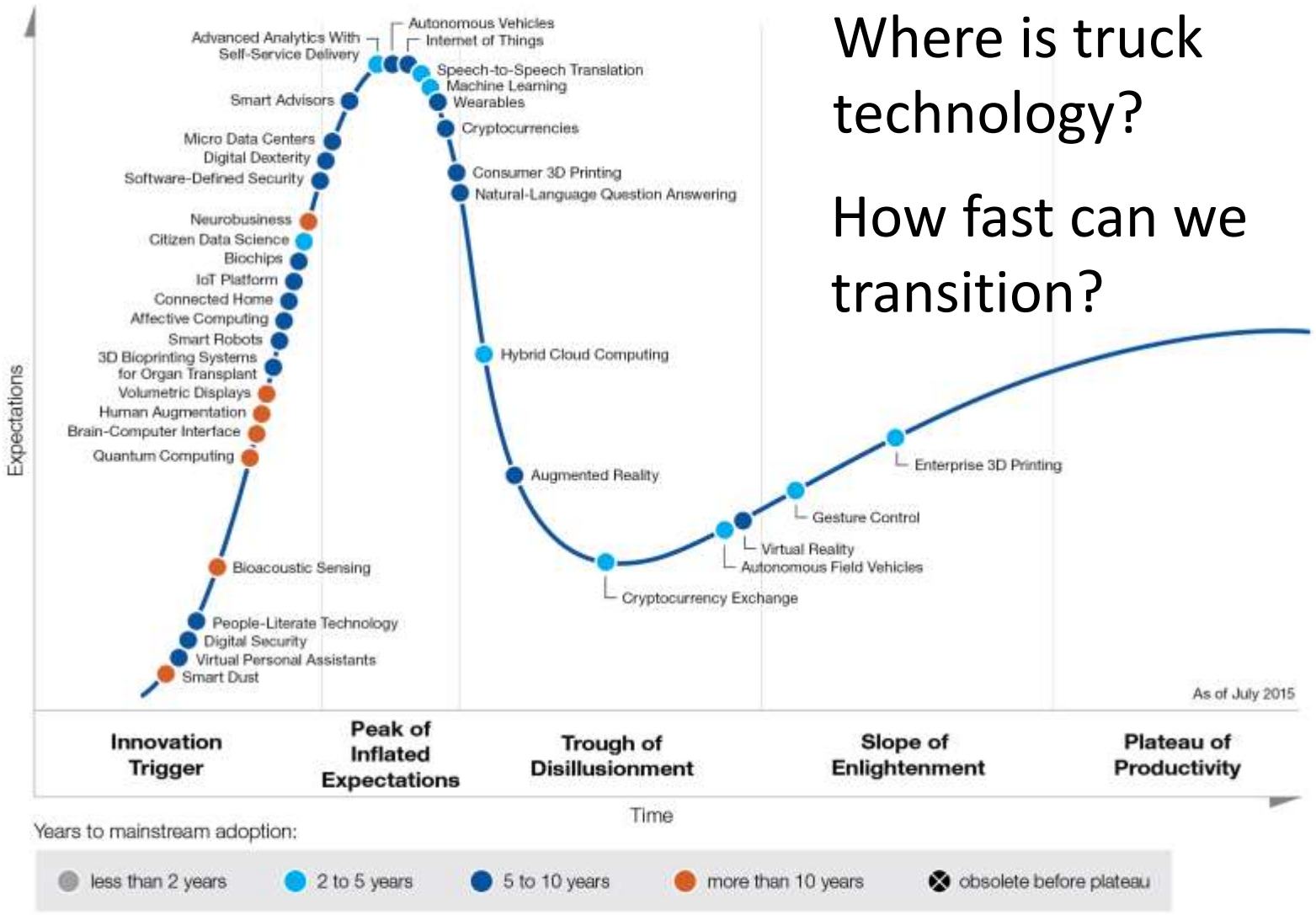
2017

Emerging Technology Hype Cycle



Where is truck technology?

How fast can we transition?

gartner.com/SmarterWithGartner

Gartner

Incentive Programs Update

Fred Minassian
Assistant Deputy Executive Officer
Science & Technology Advancement

Legislative Activities in 2017

- AB 1274, Smog Abatement Fee
- AB 134, Amendment to 2017 Budget Act
- AB 109, Amendment to 2017 Budget Act

AB 1274, O'Donnell

- Extends first smog check requirement for new vehicles from 6 to 8 years
- Consumers pay $25/yr in smog abatement fee in years 7 and 8, instead
- $21 of the $25/yr smog abatement fee goes to the Carl Moyer Program
- Generates additional $30 - $35M/yr for SCAQMD
- Funding starts in January 2019, with no sunset date

AB 134
Greenhouse Gas Reduction Fund

- $250M for Carl Moyer and Prop 1B type projects:

  $107.5M SCAQMD
  $80M SJVAPCD
  $50M BAAQMD
  $12.5M Others

- At least 80% of projects must be implemented in disadvantaged and low-income communities

AB 134
Greenhouse Gas Reduction Fund

- $100M statewide for EFMP, including:
  - $15M for SCAQMD
  - $15M for SJVAPCD
- $85M agricultural equip. emissions reductions
- $180M for CARB administered HVIP with $35M for zero-emission buses
- $140M for CVRP

AB 109
Greenhouse Gas Reduction Fund

- $27M statewide for initial implementation of AB 617
- $35M Alt. and Renewable Fuel and Vehicle Technology Fund, for agricultural sector emissions reductions
- $15M Air Quality Improvement Fund, for agricultural sector emissions reductions

VW Settlement

$423M statewide, CARB administered for NOx mitigation projects

Heavy Duty Zero Emission Truck Projects

Joseph Impullitti

Program Supervisor

South Coast AQMD

ZECT 1 Battery Drayage Trucks

- $4.2M Award from DOE + $4.2M from technology partners
- Develop 6 battery electric trucks - TransPower (4), US Hybrid (2)

Technical Accomplishments and Progress
BETs – US Hybrid

- First of two BETs deployed with TTSI in Q3 2016
- With EVSE out of service, BET #1 is not in commercial use
- TTSI in process of installing EVSEs at new location near Port of LA
- US Hybrid selected A123 as new battery supplier
- As of 12/31/2017 BET #1 accumulated 3,113 miles
- BET #2 completed in Q2 2017

US Hybrid BET#1

US Hybrid BET #2

Technical Accomplishments and Progress
BETs – TransPower

- Maintained three Electric Drayage Demonstration trucks (EDDs) in drayage service
  - EDD2 (3Rivers)
  - EDD3 (Cal Cartage)
  - EDD4 (NRT)
- Near dock and local operations within 20-mile radius from ports
- Collectively logged 37,841 miles as of 12/31/2017
- Positive feedback on quiet and smooth operations with sufficient power and torque
- Resolved early integration issues and software glitches

EDD2 – EDD4

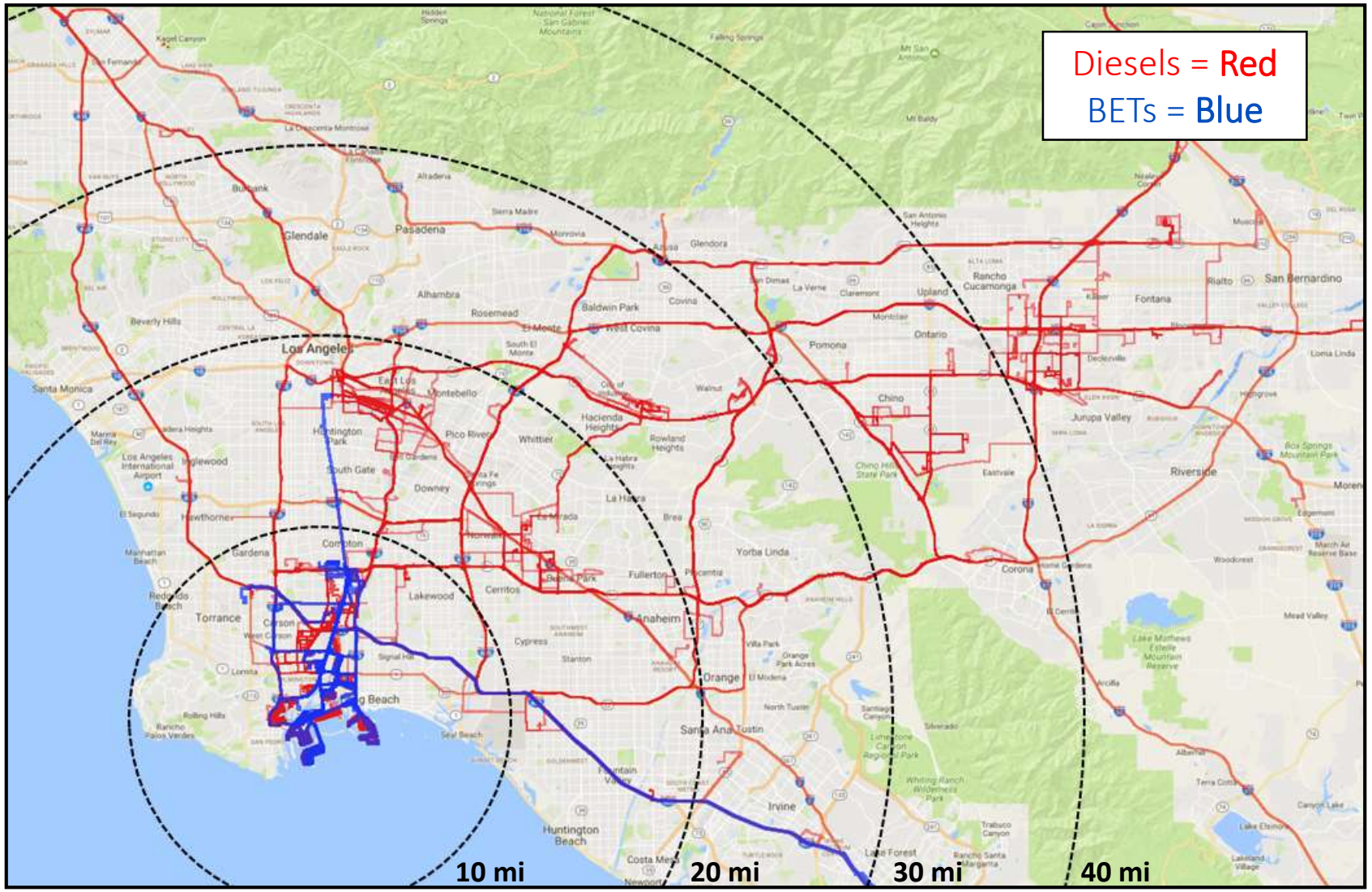
Technical Accomplishments and Progress
BETs – TransPower (continued)

- Enhanced fault detection and diagnosis for improved reliability and customer support
  - Evolving telemetric data analysis capability
  - Touchscreen Driver Interface
- EDD1 upgrade completed in Q1 2017
  - 60% higher energy density cells
  - Advanced BMS with active cell balancing
  - 50% improvement in operating range (110-150 miles)
  - Undergoing validation testing

Touchscreen Driver Interface

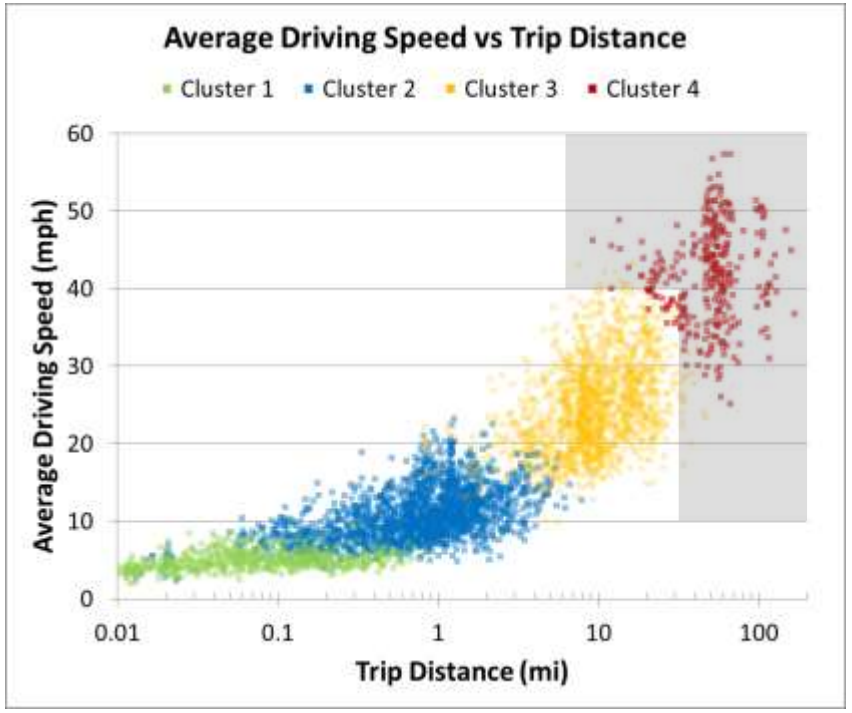
Upgraded EDD1

Range of Operations

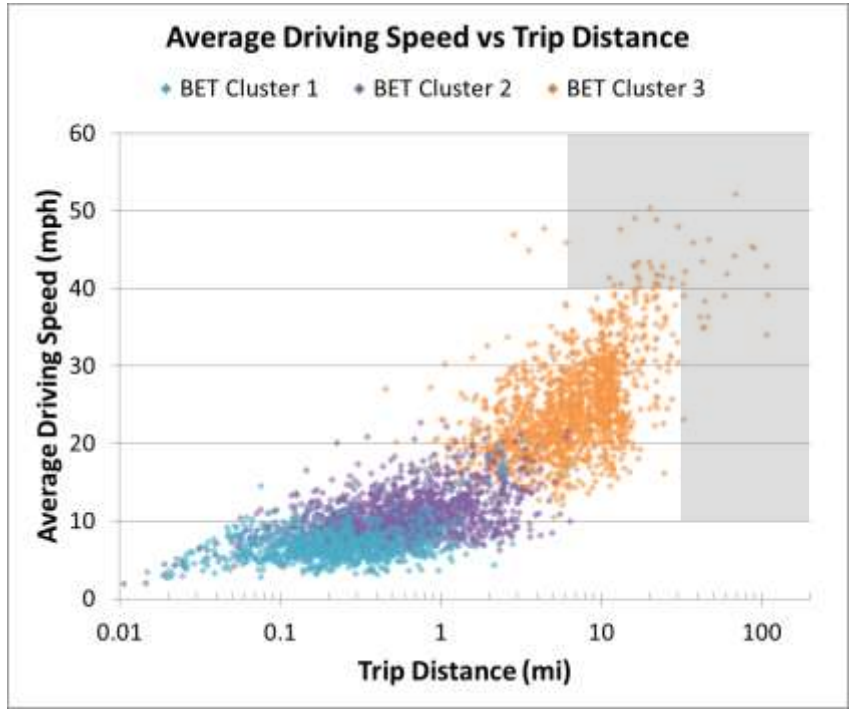


Courtesy of NREL

Trip Kinematics by Cluster



Conventional Diesels



BETs

Courtesy of NREL

Average Daily Use

	BETs[1]	COV	Conv. Diesel Filtered[3]	COV
Number of Days	488	N/A	252	N/A
Operational Time (hr)	5.33	44%	6.02	85%
Idle/Stationary Time (hr)	2.98	56%	3.67	126%
Daily Distance (mi)	46.47	43%	52.26	51%
Average Driving Speed (mph)	20.11	26%	22.45	18%
Average Total Speed (mph)	9.73	50%	11.25	46%
Kinetic Intensity (1/mi)	1.19	36%	0.85	52%
Efficiency (kWh/mi)	2.17	19%	6.64[2]	109%
Fuel Economy (MPG_{de})	18.62[2]	57%	5.67	32%
Regen Energy (kWh)	17.92	53%	N/A	N/A
Remaining SOC (%)	52.90	34%	N/A	N/A

[1] Includes vehicles: EDD2, EDD3, EDD4 through 12/31/16

[2] kWh/mi and MPG_{de} calculated using 37.656 kWh / gallon of diesel fuel

[3] Filtered days exclude days with distance >100mi and Avg. driving speed >40 mph

Courtesy of NREL

GGRF Electric Truck Projects

- $23.6M Award from ARB, $10.4M State Air Districts, $6M In Kind – Total of $40.1M
- Total of 43 Drayage Trucks
  - 25 Battery Electrics from BYD
  - 12 Battery Electrics from Peterbilt
- In addition to the Battery electrics:
  - 4 CNG Hybrids from Kenworth
  - 3 Diesel Hybrids from Volvo

BYD Electric Drayage Truck

- BYD to develop 25 BETs based on T9 Prototype
  - Phase 1 trucks (5) – Q1/Q2 2018
  - Phase 2 trucks (20) – Q3/Q4 2018
- Production of Phase 1 trucks completed ready for delivery
- One truck delivered to GSC Logistics Port of Oakland

Peterbilt Electric Drayage Truck

- TransPower/Peterbilt to develop 12 BETs based on EDD drivetrain
  - Phase 1 trucks (4) – Q3 2017
  - Phase 2 trucks (8) – Q3 2018
- Integration of EDD drivetrain in progress
- Gliders from Peterbilt have been delivered

ZECT 2 Fuel Cell Drayage Trucks

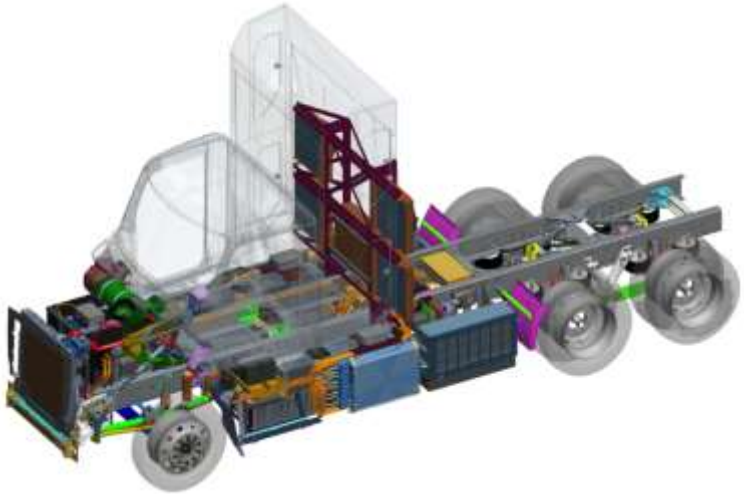
- $10M Award from DOE + $10M from SCAQMD and Funding Partners, total of $20M
- Demonstration of 7 Drayage Trucks – 6 Fuel Cell & 1 CNG Hybrid:
  - US Hybrid – 2 Fuel Cell Trucks
  - TransPower – 2 Fuel Cell Trucks
  - Hydrogenics – 1 Fuel cell Truck
  - Kenworth – 1 Fuel Cell Truck
  - Kenworth – 1 CNG Hybrid Truck

KENWORTH
A PACCAR COMPANY

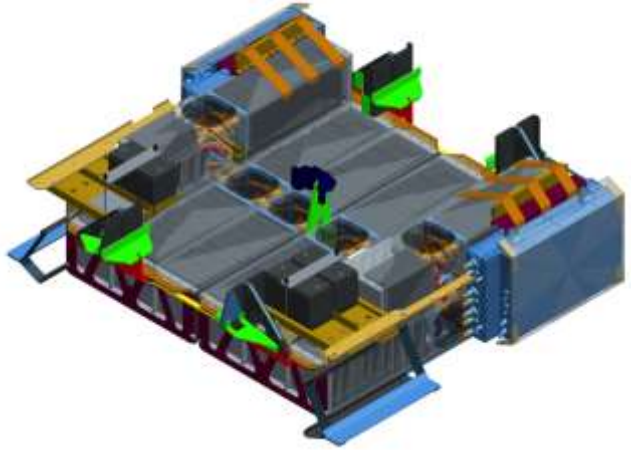
BAE SYSTEMS
INSPIRED WORK

Technical Progress

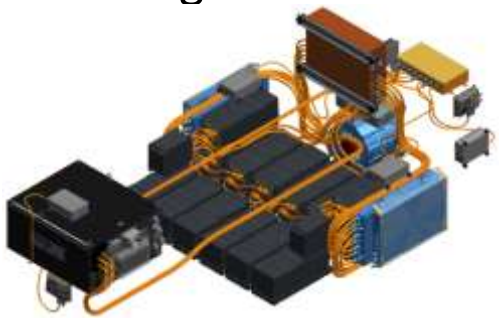
- ✓ Solid models for BAE HybriDrive™, Ballard HD85 fuel cell, high voltage battery pack and hydrogen storage system have been fitted to the T680 truck model
- ✓ Combined 100 kWh XALT battery pack enclosure with integrated cooling and center pivot to accommodate frame twist designed
- ✓ Multiple cooling loop designs for power electronics, battery pack, traction motors, and fuel cell complete
- ✓ Ballard has approved Kenworth's fuel cell integration design
- ✓ Hydrogen fuel cell drayage truck design passed critical design review



H2 Fuel Cell Truck Layout



Battery Pack Assembly



High Voltage Routing

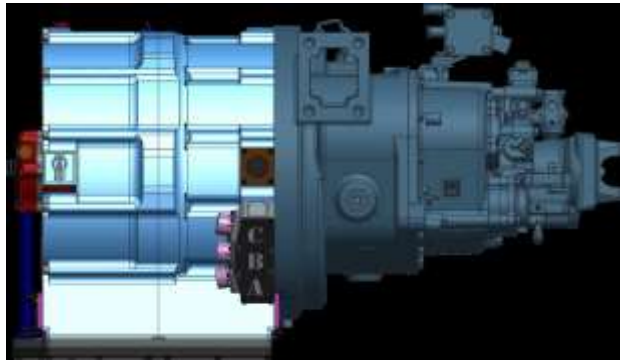
KENWORTH
A PACCAR COMPANY

BAE SYSTEMS
INSPIRED WORK

Technical Progress

- ✓ Kenworth T680 donor vehicle delivered
- ✓ Custom electric AC compressor, DC-DC converter and brake air compressor BAE power electronics components Ballard HD85 fuel cell
- ✓ Integrated oil cooled dual traction motor system on order – provides similar performance to diesel when used with Eaton 4 speed automatic transmission
- ✓ Hydrogen storage system with at least 25kg usable capacity
- ✓ Completed pre-production review
- ✓ Truck conversion began April 2017

Kenworth T680 Delivered



Traction Motor/Transmission Assembly

Click on the YouTube link below to see the
Kenworth Zero Emission Cargo Transport (ZECT) video
https://youtu.be/ShgYjFb4Pp8

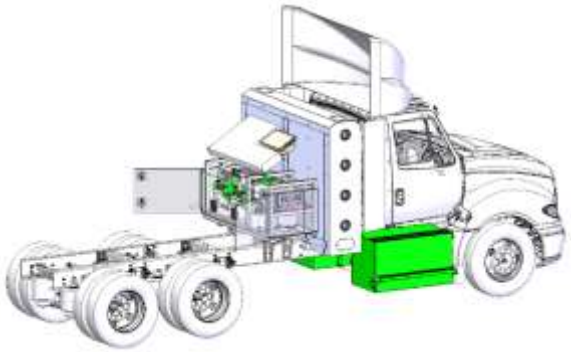
Fuel Cell Drayage Truck

Proposed Truck With APU

- Drop battery energy storage to 120kWh (80%DOD)
- Add gaseous storage (17 kg H2), FC Range Extender
- Increase range to 150 miles

Vehicle Packaging

Major components are on the truck, including motive drive system, power conversion/accessories system and fuel system.



Technical Progress

Battery Testing

- Battery modules have been fabricated and tested using the AV900, and are awaiting the pack frames and BMS for final assembly. Data shows the modules fully charged and balanced.

Hardware In-the-loop Testing

- Software development testing has been initiated using the benchtop fuel cell / DC-DC conversion system.

Technical Progress

Fuel Cell System Testing

- Structural fabrication of the Fuel Cell Assembly is complete
- Major components were installed on vehicle and wired in April 2017

Spring-Summer Schedule

1. Completion and test of battery, installed on truck
2. Completion and test of Fuel Cell Auxiliary Power Pack (FCAPP)
3. Install FCAPP on truck, test and commission truck
4. Truck to be available for ACT Conference
5. Road test, evaluation of fuel cell hybrid truck
    1. 500 mile shakedown
    2. Roadability (speed, acceleration, hill climb records)
    3. Range as bobtail, with trailer.
6. Fabrication of second truck, with fuel system, FCAPP
7. Delivery of first truck to customer, initial training
8. Delivery of second truck

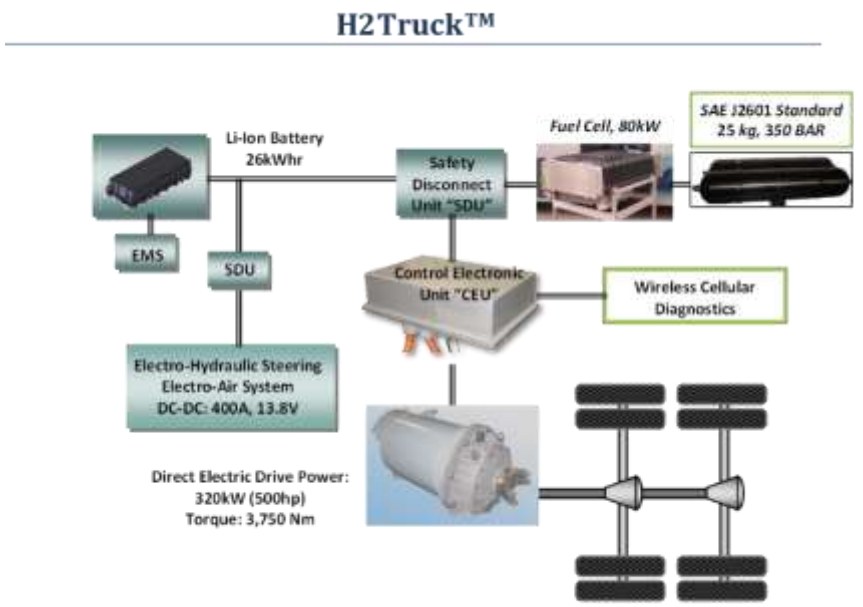
Fuel Cell Drayage Truck

Technical Progress
Fuel Cell Testing

- Completed the 80kW fuel Cell with integrated high efficiency isolated dc-dc converter, tested at the test-stand in South Windsor facility.

Technical Progress
Design/Integration

- Truck has been partially integrated



Fuel Cell Electric Class-8 Truck Powertrain System Configuration

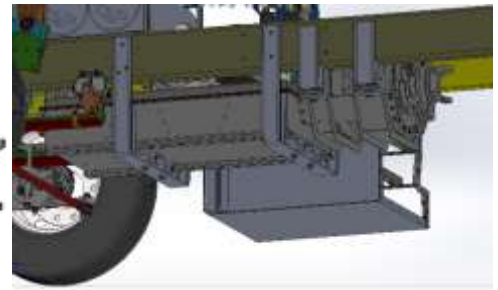
Technical Progress

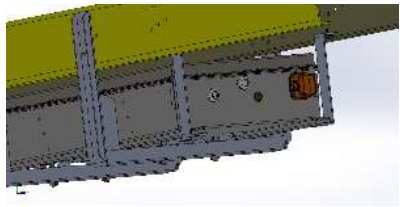
Hydrogen Storage

- Completed the design, procurement and installation of the H2 tanks in collaboration with Agility with after sales support.

Auxiliary Systems

- Battery, drive system and fuel cell vehicle packaging design completed.
- Auxiliary system designed and partially integrated





HYDROGENICS
SHIFT POWER | ENERGIZE YOUR WORLD

Technical Progress

CEC & DOE Project Status

- ✓ Design and Procurement Phase 40% Complete
- ✓ Developed Guiding Document for design, BOM and build process
- ✓ Chassis Selection and Optimization:
  - ✓ Daimler provided engineering support
  - ✓ Obtained all CAD drawings and electrical schematic for truck design
- ✓ Completion of component selections for fuel tanks and thermal management
- ✓ Evaluation of multiple vehicle components layout:
  - ✓ Evaluated packaging of main components
  - ✓ Constraints include weight distribution, aesthetics, serviceability and capacity
- ✓ Contract for DOE ZECT project in process

DAIMLER

SIEMENS

HYDROGENICS
SHIFT POWER | ENERGIZE YOUR WORLD

Future Trucks

Future Trucks

Proposal to ARB: Kenworth & GM Partnership for Heavy Duty Truck

Future Trucks

Future Trucks

Volvo Announces Electric Trucks

In-Use Emissions Testing Program Update

Clean Fuels Advisory Group
January 31, 2018

Adewale Oshinuga, Program Supervisor




Cleaning the Air That We Breathe…

In-Use Emissions Testing Program

- On-road heavy-duty engines
  - Meet 0.2g/bhp-hr NOx and 0.01g/bhp-hr PM emissions
  - CARB optional NOx emission standard
  - In-use emissions may be higher
- Increase vehicle population with newer technologies
  - Large NOx and PM emissions reduction
  - New generation natural gas engine
- In-use emissions testing program
  - University of California Riverside/CE-CERT
  - West Virginia University

In-Use Emissions Testing Scope of Work

- Collect and analyze vehicle activity and emission data
- Assess effectiveness of current heavy-duty drive cycles
- Conduct in-use emissions testing of 200 heavy-duty vehicles
- Test Matrix

Vehicles	Number	Fuel
Goods Movement Trucks	90	**Natural gas, Renewable natural gas, diesel, renewable diesel, and alternative fuels (hybrid and fully electric)**
Delivery trucks	45	
Refuse trucks	25	
School and transit buses	40	

- Assess technology and fuels on fuel consumption and emissions
- Match technology to vocation

In-Use Emission Testing Hardware

- Portable Activity Measurement System (PAMS)

- Portable Emission Measurement System (PEMS)

- Chassis Dynamometer

- Real-World In-Use Emission Laboratory

Test Vehicle Activity Matrix

Vocation	Transit	School Bus	Refuse	Delivery	Goods Movement
Number of PAMS Vehicles	20	20	25	45	90
CNG 0.20g	8	8	17	15	20
CNG 0.02g	2	2	6	0	16
Diesel 0.20g	2	5	2	16	40
Diesel (No SCR)	0	1	0	1	2
Other Alt Fuels					
LNG/Diesel HPDI (0.20g)	0	0	0	0	4
Diesel-Electric Hybrid	2	0	0	4	0
Electric	4	1	0	4	6
Fuel Cell	2	0	0	0	0
CNG Hybrid	0	0	0	0	0
Propane	0	2	0	4	0
RD 0.20g	0	1	0	1	2
RD (No SCR)	0	0	0	0	0

Test Vehicle Emission Matrix

Vocation	Transit	School Bus	Refuse	Delivery	Goods Movement
Number of PEMS Vehicles	10	10	15	20	45
CNG 0.20g	4	3	10	4	12
CNG 0.02g	2	2	3	0	11
Diesel 0.20g	2	2	2	9	16
Diesel (No SCR)	0	1	0	1	2
Other Alt Fuels					
LNG/Diesel HPDI (0.20g)	0	0	0	0	2
Diesel-Electric Hybrid	2	0	0	4	0
Electric	0	0	0	0	0
Fuel Cell	0	0	0	0	0
CNG Hybrid	0	0	0	0	0
Propane	0	2	0	2	0
RD 0.20g	0	0	0	0	2
RD (No SCR)	0	0	0	0	0

Chassis Dynamometer Test Matrix

Vocation	Transit	School Bus	Refuse	Delivery	Goods Movement
Number of Test Vehicles	10	6	12	12	20
CNG 0.20g	2	1	6	2	2
CNG 0.02g	2	1	2	0	2
Diesel 0.20g	2	1	2	2	6
Diesel (No SCR)	0	1	0	1	2
Other Alt Fuels					
LNG/Diesel HPDI (0.20g)	0	0	0	0	2
Diesel-Electric Hybrid	1	0	0	2	0
Electric	1	1	0	2	2
Fuel Cell	1	0	0	0	0
CNG Hybrid	0	0	0	0	0
Propane	0	0	0	1	0
RD 0.20g	1	0	2	1	2
RD (No SCR)	0	1	0	1	2

Real-World In-Use Test Matrix

Vocation	Transit	School Bus	Refuse	Delivery	Goods Movement
Number of Test Vehicles	0	0	0	0	10
CNG 0.20g	0	0	0	0	2
CNG 0.02g	0	0	0	0	1
Diesel 0.20g	0	0	0	0	4
Diesel (No SCR)	0	0	0	0	2
Other Alt Fuels					
LNG/Diesel HPDI (0.20g)	0	0	0	0	1
Diesel-Electric Hybrid	0	0	0	0	0
Electric	0	0	0	0	0
Fuel Cell	0	0	0	0	0
CNG Hybrid	0	0	0	0	0
Propane	0	0	0	0	0
RD 0.20g	0	0	0	0	0
RD (No SCR)	0	0	0	0	0

Status of In-Use Emissions Testing

- Vehicle recruitment
- Collection and analysis of vehicle activity and emission data
- In-use emission testing
  - Chassis dynamometer emission test
  - Real-world in-use emission test
- Project schedule
  - Started in Q4 of 2017
  - Ends in Q4 of 2018
  - Draft final reports in Q1 of 2019

In-Use Emissions Testing Funding Partners

- SCAQMD
- CEC
- CARB
- Southern California Gas Company

Near-Zero Emission Heavy-Duty Engine Technology: Gaseous and Liquid Fuels

Joseph Lopat

Clean Fuels Advisory Group

January 31, 2018

Key Projects

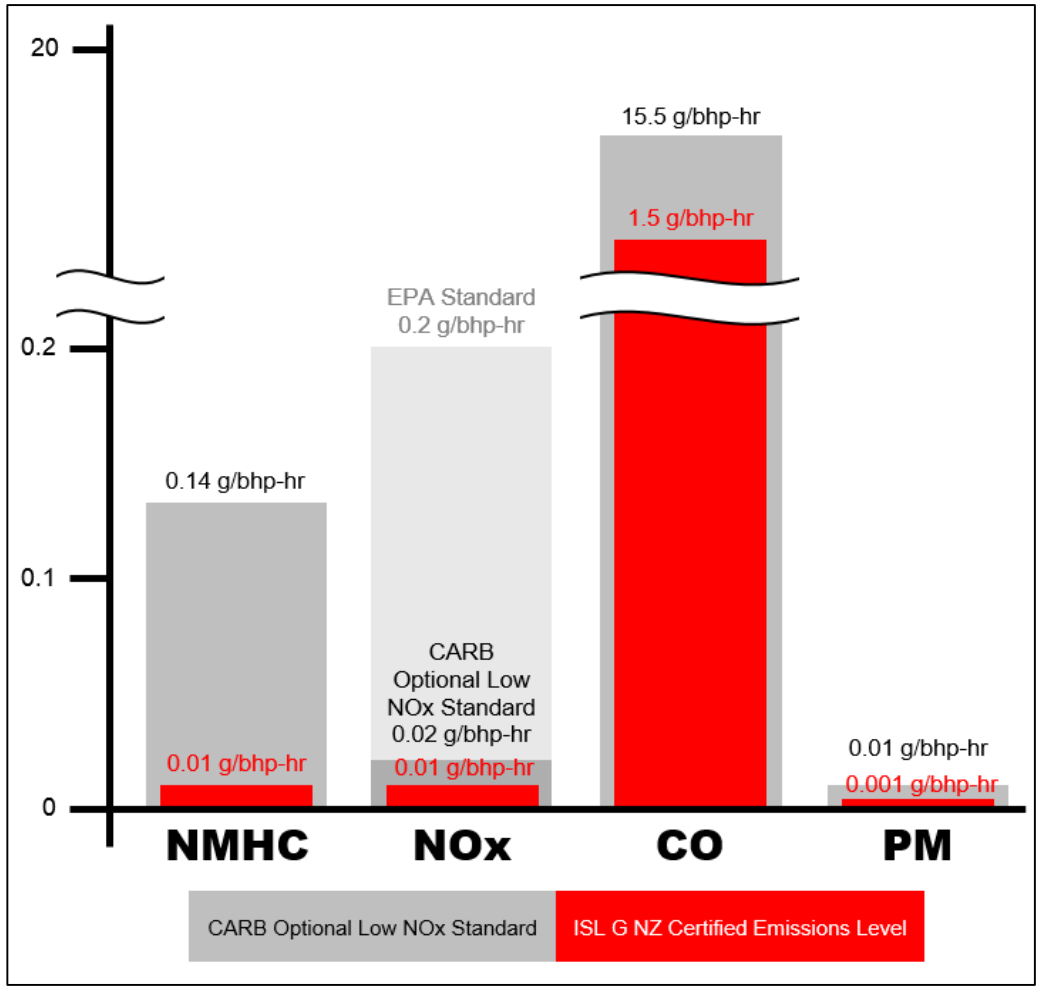
8.9- and 12-liter CNG engine CARB Certified at 0.02 g/bhp-hr Nox

ONGOING 0.02 g/bhp-hr NOx Projects

- 13-liter diesel conversion to CNG
- 15–liter diesel engine
- 8.8-liter CNG engine for class 4-8 trucks
- Opposed Piston Diesel Engine
- 15-Liter diesel Cylinder Deactivation

Cummins Westport(CWI)

- 8.9-liter and 12-liter CNG engines certified below CARB optional Low-NOx standard
  - Closed Crankcase Ventilation
  - Stoichiometric WG turbo
  - Modified single port injection
  - Larger Catalyst
  - Controller software tuned for performance
  - 8.9 –liter 300 HP 1000 ft lb Torque
  - 12-liter 450 HP, 1450 ftlb Torque
  - Total project > 13 million, SCAQMD cost share 4 million



CWI engines Fleet Demonstrated

Drayage,Buses, Refuse

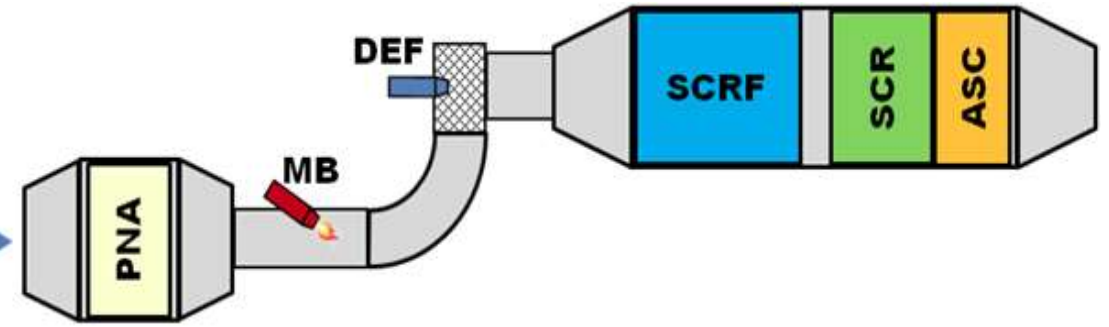
- 560,000 bus and refuse truck miles with 9-liter CNG engine
- Additional 12-liter Beta engines added and tested in LA Basin
- Over 600,000 current miles tested in Heavy-Duty trucks with 12-liter CNG engine

North American Repower

- 13-liter diesel engine conversion to CNG
- Development to increase CNG power with higher Compression Ratio and boost
- Achieve Ultra-Low NOx through Lean Burn
- Increase in efficiency compared to diesel
- Advanced modeling to improve drive cycles
- Goal for Production readiness 2019
- Total project cost $1.9 million, SCAQMD cost share $200,000

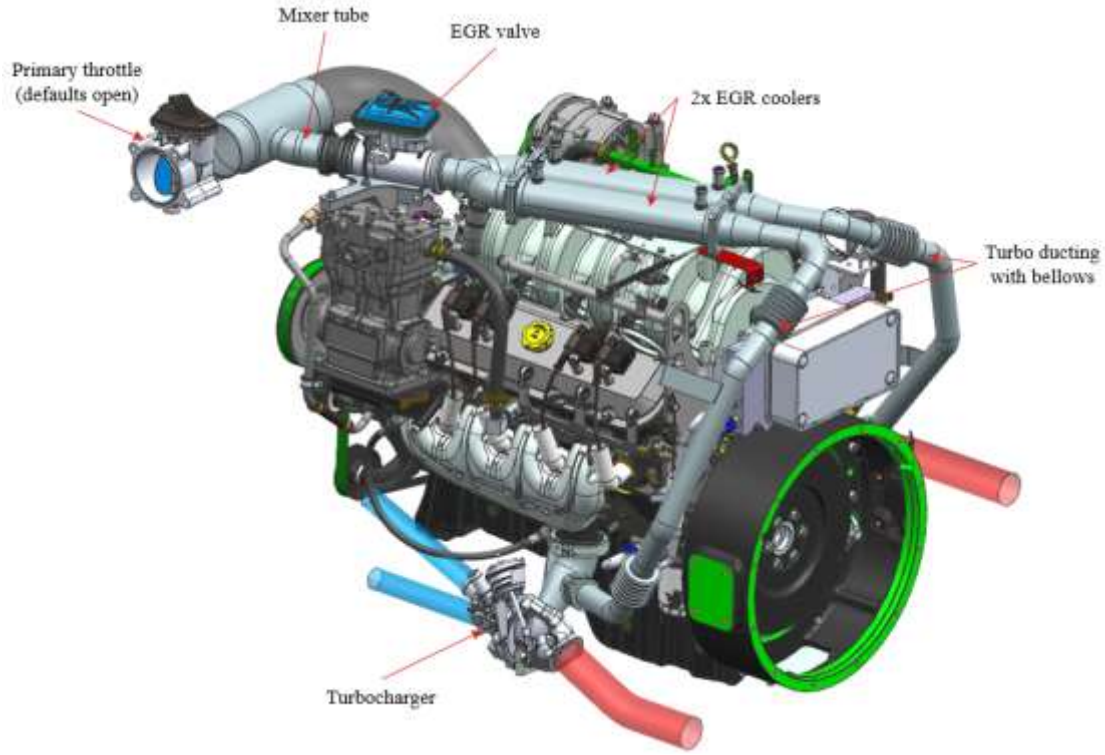
SwRI Heavy-duty Ultra-low NOx Diesel

- Part of a Three stage project with CARB to develop a 0.02 g/bhp-hr diesel engine
- Research emphasis on low-loads and cold starts
- Significant After-treatment development
- Transfer technology to a 15-liter heavy duty diesel engine.
- Total project cost $1.3 million, SCAQMD cost share $287,000



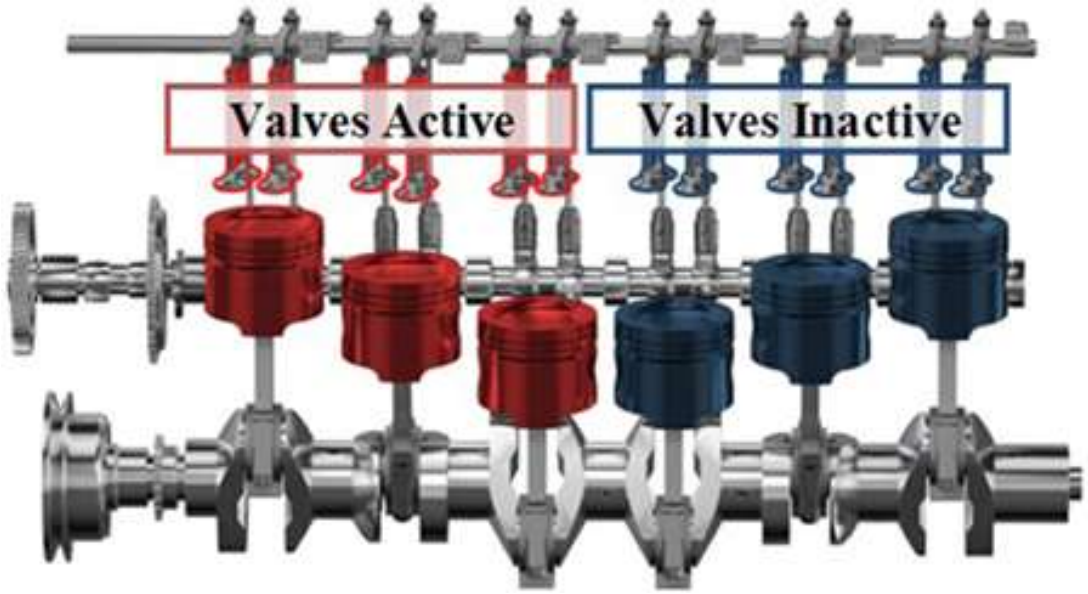
Power Solutions International

- 8.8-liter CNG prototype
- Twin turbo
- Dual EGR
- Three Way Catalyst
- 0.02 g/bhp-hr Nox
- Intended for full production 2019
- Total project cost $ 2million,
  SCAQMD share $750,000



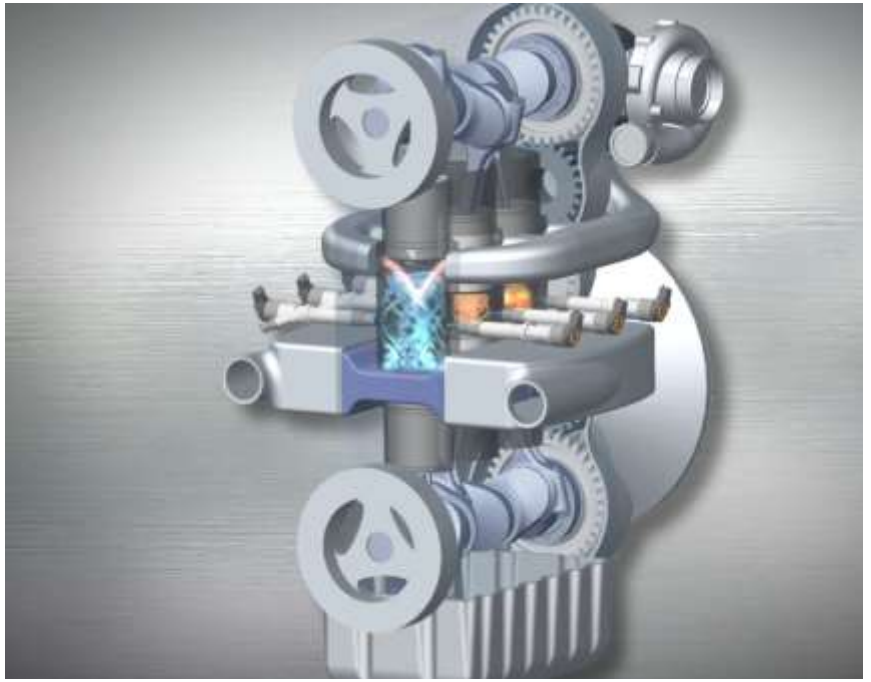
West Virginia University cylinder deactivation

- Thermal Management strategy
- Heavy-duty diesel engine
- Joint venture with Cummins
- Ultra-low NOx
- Jacobs Vehicle Systems valve control
- Address Noise and Vibration concern
- Software developmental controls
- Total Project cost $700,000, SCAQMD cost share $250,000



Achates Power Opposed Piston Engine Project

- Greater efficiency 9.8 liter 3 cylinder 450 HP and 0.02 g/bhp-hr NOx
  - $7 million CARB GGRF Grant
  - Develop and build 4 engines
  - SwRI proven after-treatment design
  - Peterbilt integration
  - Walmart and Tyson foods demonstration
  - Total project cost $17 million, SCAQMD cost share $1 million



Heavy-duty Engine Summary

- Lessons learned
  - Technology pathway to successful production of Ultra-low NOx CNG engines
  - Pathways to keeping the Catalyst hot are achievable without fuel penalty in diesels
- Future Goals
  - Need more OEM involvement with HD diesel and CNG engine products capable of 0.02 g/bhp-hr Nox for class 8 trucks
- Public policy goals
  - Achievement of emission reductions in Ports and highly impacted environmental justice communities

Medium-Duty Zero and Near-zero Emission Vehicle

Technology and Demonstration Office
Air Quality Specialist

Seungbum Ha

Zero emission trucks

South Coast AQMD

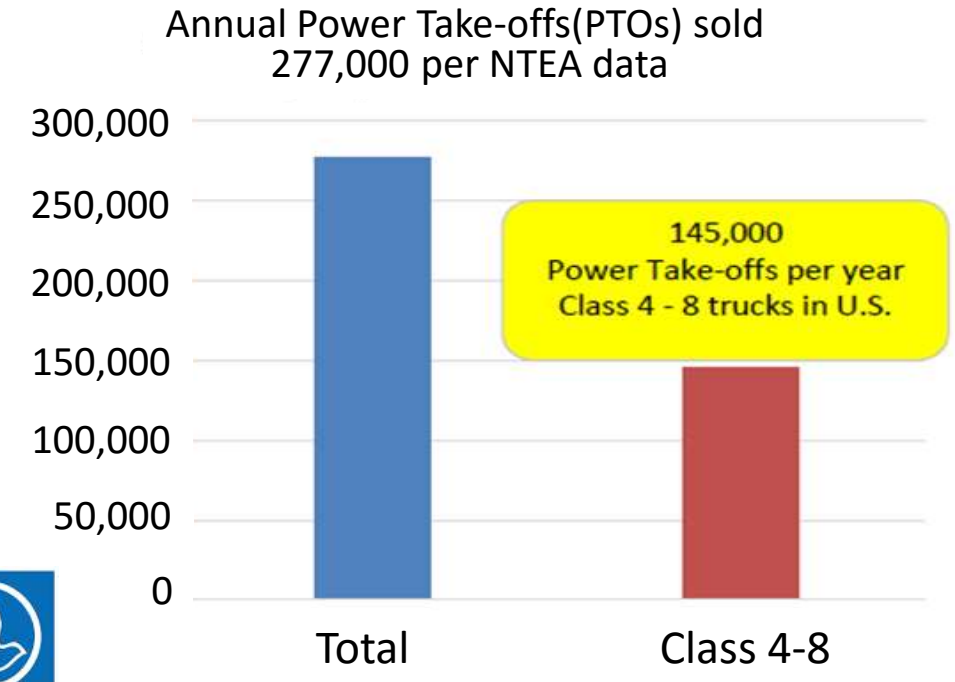
1. **Develop and Demonstrate Medium-Heavy Duty Plug-in Hybrid Work Truck**

2. **Fuel Cell Extended-Range Powertrain for Parcel Delivery Trucks**

Why focus on electrification of work truck

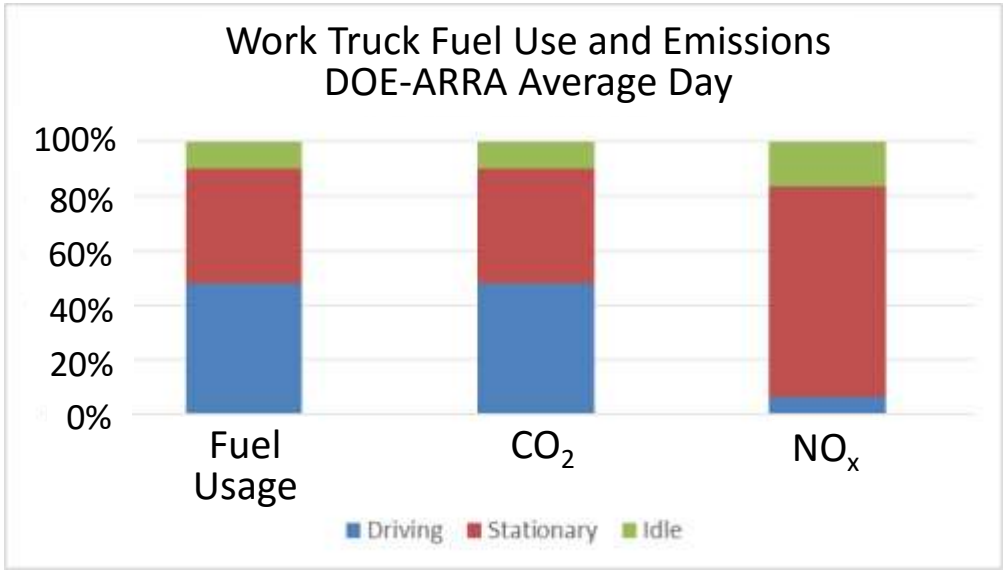
Work Trucks represent about 1/3 of total medium and heavy duty vehicle production.

- PTO based Work Truck Market: Over 145,000 annually
- Retrofit: Over 1.4 million existing large work trucks



An Average Day

- Drive Distance: 26 Miles
- Stationary Work : 2.8 Hours
- Idle time: 1.6 hours
- ~50% of fuel use and GHG emissions occur during stationary events
- 80-90% of NOx emissions occur during stationary events



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Work Truck Duty Cycle – Large Aerial Example

Operation of utility vehicles that are targeted by Odyne typically involves:

- Short drive to the jobsite
- Extensive work time with intermittent loading at the jobsite
- Engine charge if needed, depends on application and usage
- Short drive back to garage
- Plugin Charge overnight

- Varying loads throughout day
- Ideal situation ending shift with low SOC

South Coast AQMD

Develop and Demonstrate Medium-Heavy Duty Plug-in Hybrid Work Truck

NGTNews | Next-Gen Transportation. ARTICLES

Odyne Systems, LLC Receives $2.9 Million Contract from U.S. Department of Energy

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Odyne Systems LLC has received a $2.9 million contract from the U.S. Department of Energy (DOE) to develop and demonstrate plug-in hybrid work trucks (Class 5 through 7) that reduce fuel consumption by more than 50% and eliminate fuel consumption during stationary operations.

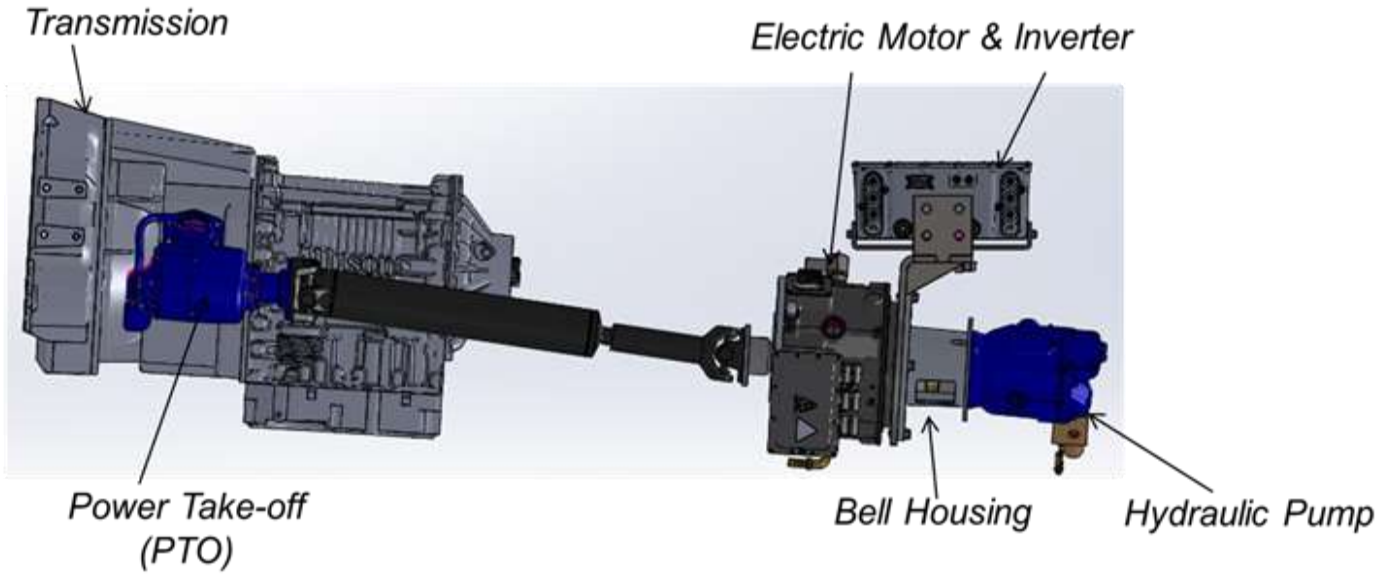
The total project, including contributions by Odyne Systems and its partners, is anticipated to be approximately $7 million.

- Develop M/HD PHEV work trucks
  - Simulation Model for Powertrain Development and Optimization
  - Battery System Development
  - Vehicle Integration
    - PHEV powertrain and control system
    - Battery system
    - Electrified job site equipment
- 12 Month Field Demonstration
  - 5 in South Coast – Sempra Energy and Others
  - 5 in Southeast US – Duke Energy
- AQMD cost share: $900,000

South Coast AQMD

Odyne – ePTO power train

Flexible, Minimally Intrusive Design



U.S. Patents 7,471,066 7,830,117 8,408,341 8,818,588 8,905,166 8,978,798 9,061,680 9,283,954

Other Patents Pending

- Launch assist and regenerative braking through PTO connection:
  - Can be separated from drive train by disengaging PTO clutch
- Jobsite functions primarily supported by Battery/Electric Motor:
  - Can be powered by Diesel Engine during field recharge by automatic engine start and engaging PTO clutch

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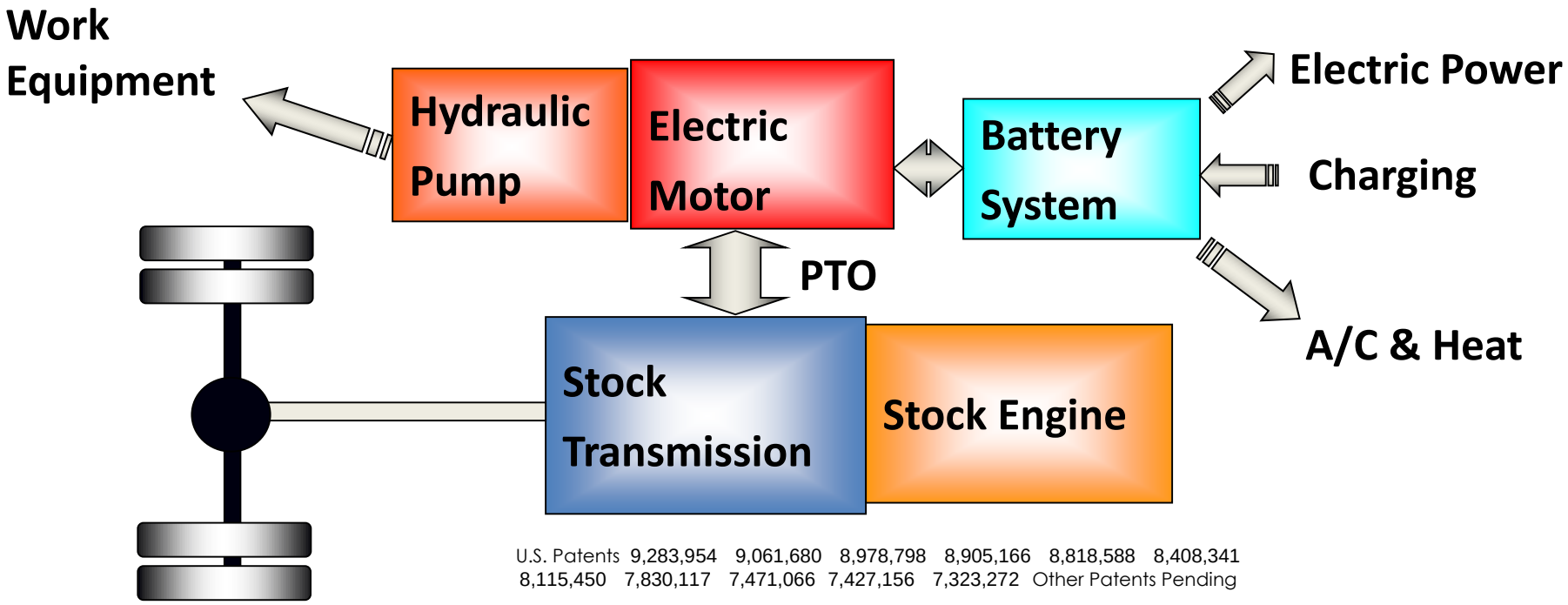
Odyne Hybrid Architecture



Parallel Hybrid Solution

- Low validation and capital equipment costs
- Ability to retrofit to existing vehicles

OEM Compatible

- No modifications required to drivetrain
- Simplified integration through power take-off (PTO)

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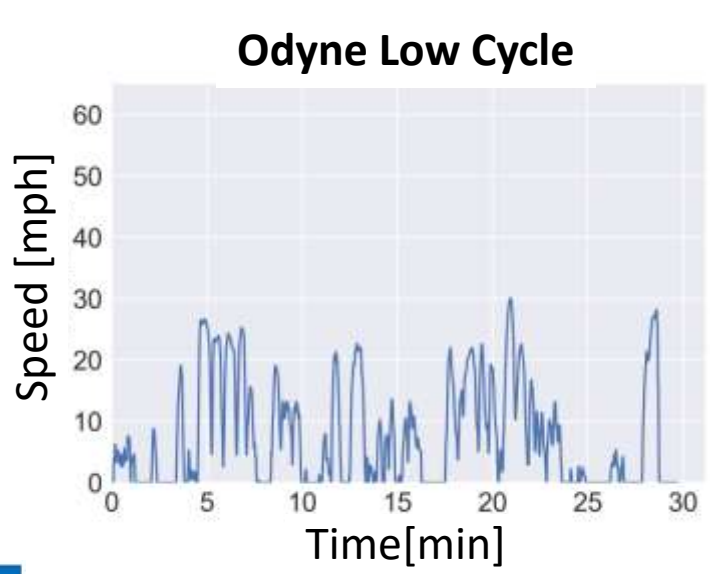
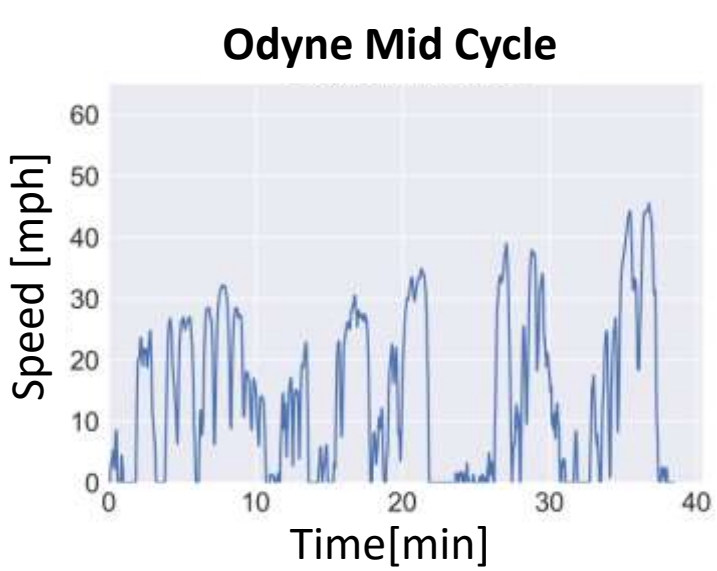
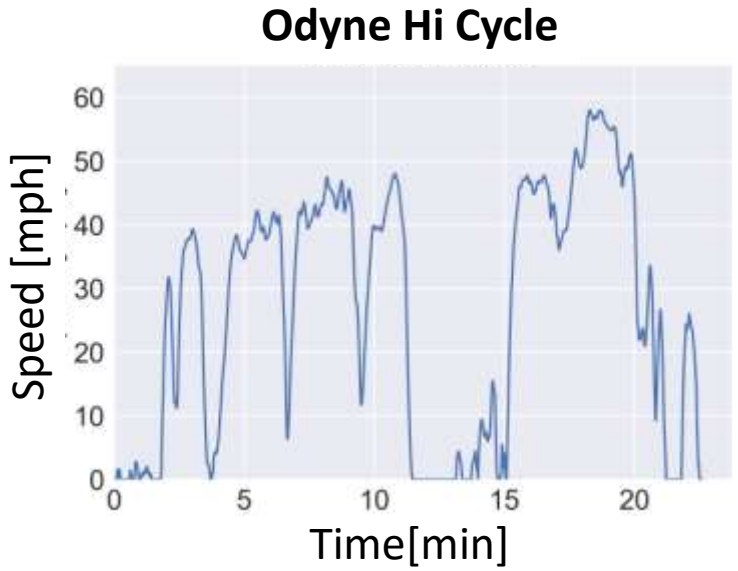
Powertrain Development and Optimization

- Combination of simulation and dynamometer test
  - Development of driving cycle







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Powertrain Development and Optimization

- Combination of simulation and dynamometer test
  - Baseline Dynamometer Testing

  - Powertrain Simulation
    - ➢ Simulink model representing the current Hybrid system to Oak Ridge National Laboratory (ORNL) for evaluation and review

South Coast AQMD

1. Develop and Demonstrate Medium-Heavy Duty Plug-in Hybrid Work Truck

2. Fuel Cell Extended-Range Powertrain for Parcel Delivery Trucks

Fuel Cell Extended-Range Powertrain for Parcel Delivery Trucks

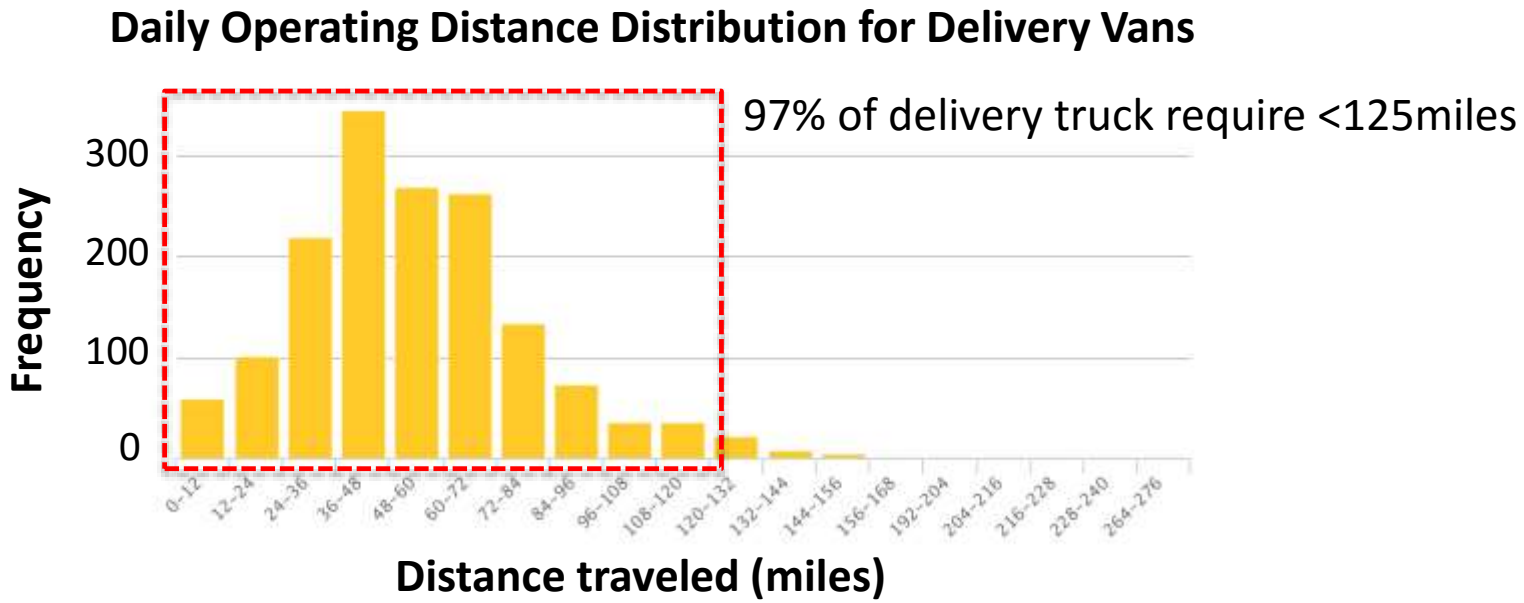
- Local operations with frequent stops
- Return-to-base fleets for centralized recharging/refueling

- Fuel cell extended-range powertrain expected to support performance and operational needs, all with zero emissions
- AQMD cost share: $589,750

South Coast AQMD

Fuel Cell Extended-Range Powertrain for Parcel Delivery Trucks

- Goal: Meet vehicle performance specifications
  - – Meet performance of existing delivery vans (diesel, CNG, electric)
  - – Increase existing route length capability of zero-emission delivery van from 70 miles to 125 miles
  - – Modeling for driving simulation

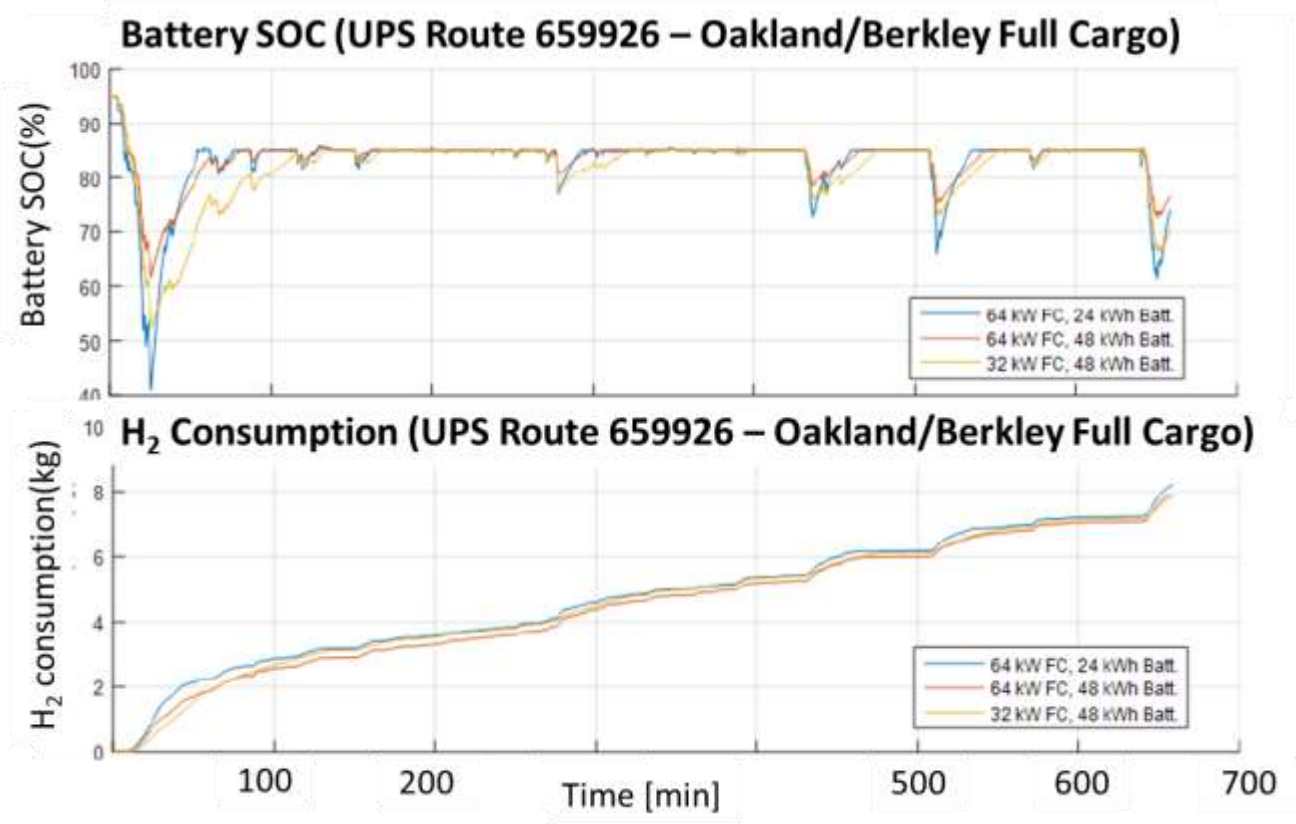


South Coast AQMD

Source: Walkowicz, K.; Kelly, K.; Duran, A.; Burton, E. (2014). Fleet DNA Project Data. National Renewable Energy Laboratory.]

Vehicle component design

- Goal: Minimize component sizes to reduce cost while meeting UPS route demands and outperforming battery electric vans.
  - Fuel Cell Size - 16 kW vs. 32 kW vs. 64 kW fuel cell stack
  - Battery Size - 30 kWh vs. 45 kWh vs. 60 kWh
  - Hydrogen Fuel Storage Size



To obtain 125 mile range, at least

- 45 kWh battery
- 32 kW fuel cell
- 10kg hydrogen tank

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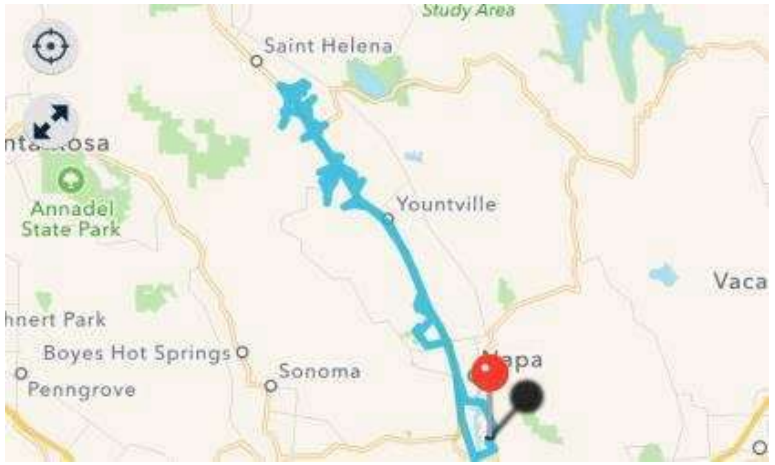
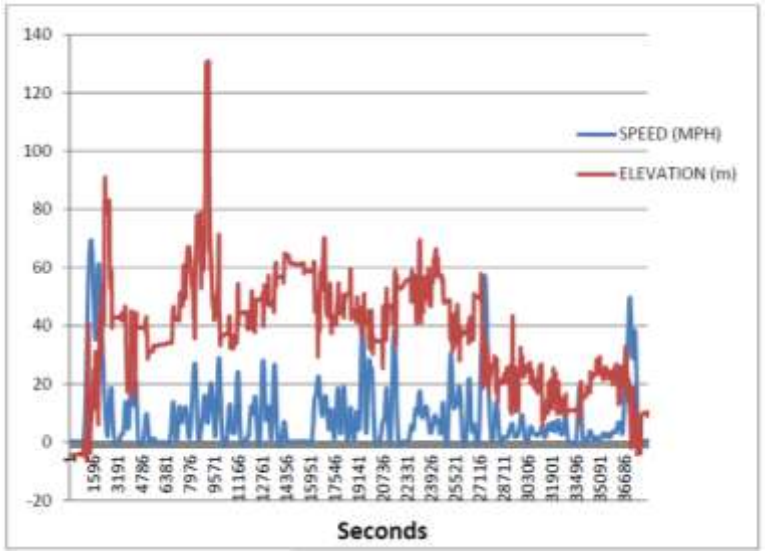
Vehicle design & simulation





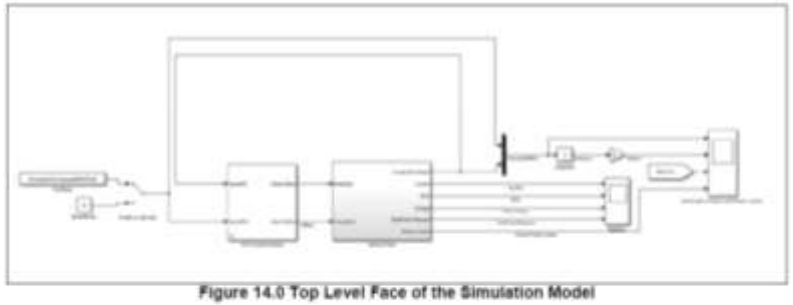
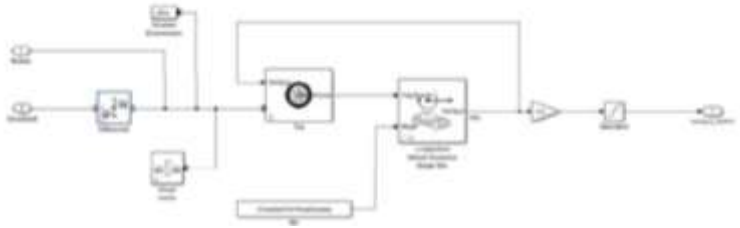


Figure 14.0 Top Level Face of the Simulation Model

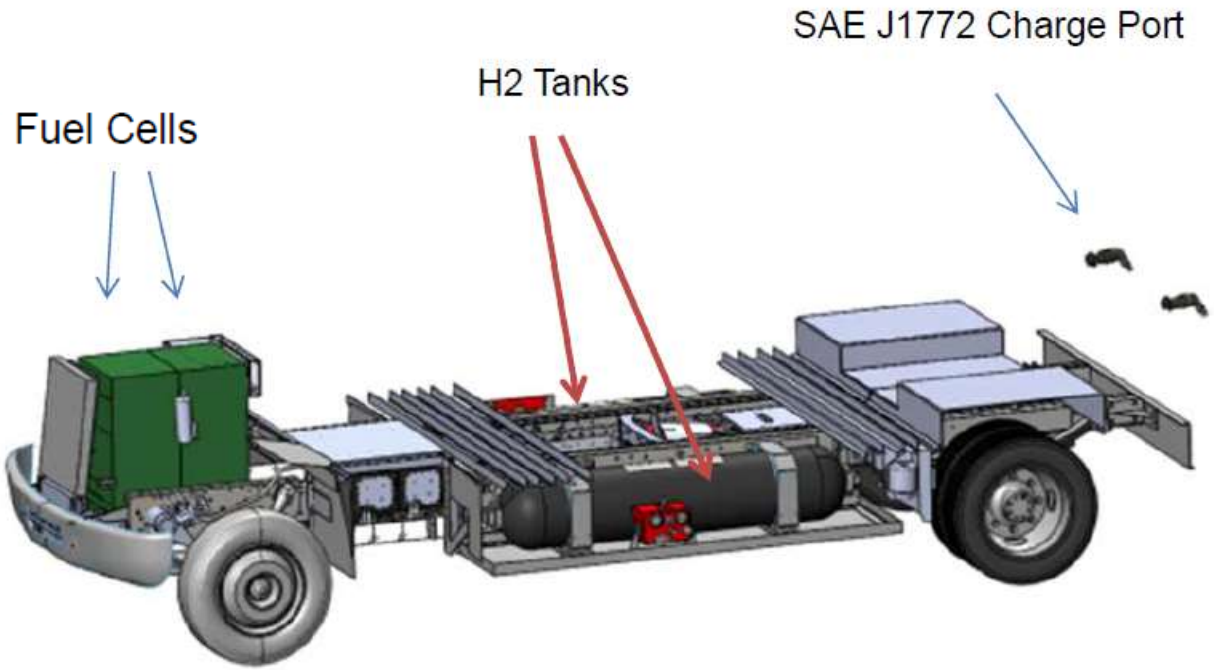


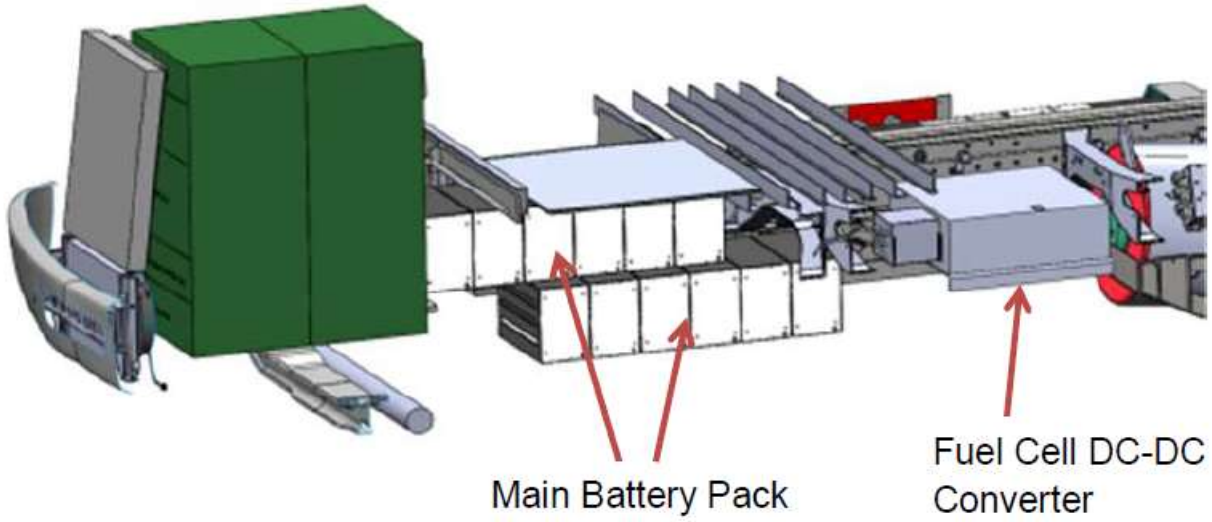
UPS FCXRDT with 71kWh of battery, combined 30kW fuel cell engine and 10kg of Hydrogen fuel tank

The NAPA route investigated was 102.8 miles and the vehicle had 1.67kg of Hydrogen fuel left and 39.7% of the battery left.

South Coast AQMD

Vehicle design & simulation





South Coast AQMD

Summary

❑ Plug-in hybrid work truck

Objective: To develop and demonstrate medium-heavy duty Plug-In Hybrid Work Trucks

Relevance:

- Advanced work truck with a ≥50% reduction in fuel consumption and greenhouse gases when compared to a conventional diesel vehicle baseline,
- comprised of bucket trucks, digger derricks and underground utility trucks
- Improvement of the overall return on investment (ROI) of the vehicle system

Accomplishments: Progress on simulation work and dyno test

❑ Fuel cell range extended delivery truck

Objective: To substantially increase the zero emission driving range and commercial viability of electric drive medium-duty delivery trucks.

Relevance: Fuel cell hybrid electric delivery van design, build, validation, deployment, and data collection project in the UPS fleet environment. Performance objectives includes 125 mile range and over 95% of UPS routes

Accomplishments: Completed vehicle design and dynamic simulation

Renewable Transportation Fuels

Clean Fuels Advisory Meeting

South Coast Air Quality Management District
January 31, 2018

Phil Barroca
Air Quality Specialist, Technology Demonstration
Technology Advancement Office

South Coast AQMD

Overview of Projects

- **Renewable Natural Gas – Local Production and Demonstration**
  - CR&R – AD (High Solids Food and Green Waste); Perris, CA
  - KORE Infrastructure – Pyrolysis (Biosolids, other low moisture carbon materials); Rialto and Los Angeles, CA
- **Renewable Natural Gas and Renewable Diesel - Research**
  - UCR – CE-CERT - RNG Research Center and Viability of RNG in CA
  - GNA – White Papers - RNG and Renewable Diesel (RD)
- **Renewable Natural Gas – Retail**
  - Clean Energy (REDEEM) and Local Transit Authorities
  - OntarioCNG – CNG Station Expansion and RNG fueling

RNG and RD Fuels - Roles

- Renewable, Sustainable, Domestically produceable
- Reduce Dependency on Petroleum Based Fuels, Energy Security, Federal Renewable Fuel Standard
- Reduce Greenhouse Gas (GHG) emissions, California's Low Carbon Fuel Standard, Renewable Portfolio Goals (50% by 2030)
- Reduce NOx and PM emissions
  - For RNG when combined with NZ technology
  - For RD can reduce NOx by 3%-18% (without SCR)
- Productive Use of Biomass Waste to: Fuel, Fertilizer, Soil Amendment, others
  - Food and Green wastes, including woody biomass
  - Livestock Operations
  - Wastewater Treatment
  - Other organic wastes

Renewable Natural Gas (Biomethane)

- **Renewable Natural Gas (RNG)** or biomethane - interchangeable with conventional natural gas.
- Production Methods: biochemical process, such as anaerobic digestion, or thermochemical processes, such as gasification.
- Needs conditioning and upgrading to remove impurities - water, CO_2, H_2S, and other trace componds

Renewable Diesel (Not Biodiesel)

- **Renewable Diesel (RD)** is also known as Hydrotreated Vegetable Oil (HVO) or second-generation biofuel.
- Feedstocks: biomass waste and residues, often the same feedstocks as biodiesel.
- Production Methods: hydrotreating, thermal conversion, or biomass-to-liquid. Impurities are removed from the raw materials during processing and hydrotreated at a high temperature.
- identical chemical composition and is fully interchangeable with fossil diesel fuel and has demonstrated a 3-18% NOx reduction in ICEs without SCR (CARB)
- **Biodiesel (B)** is also known as Fatty Acid Methyl Ester (FAME).
- Feedstocks: vegetable oils or fats, such as soybean oil, algae and chicken fat, as well as waste vegetable oil (WVO).
- Production Method: transesterification (use of methanol) to purify the materials into biodiesel.
- OEMs require Biodiesel be blended up to 20% (B20) with conventional diesel. Biodiesel at certain blend levels increases NOx emissions in diesel exhaust (CARB).

RNG Projects discussed

- CR&R
- KORE Infrastructure
- Ontario CNG
- UC Riverside

CR&R

CR&R – Anaerobic Digestion of High Solids Food and Yard Waste

- Phase 1 Completed in 2016
  - 80,000 Tons/Year ; 890,000 DGE/Year; fueling 75 refuse vehicles daily
- Phase 2
  - Commissioning - end of February 2018
  - Online - June 2018 (60-90 days from commissioning)
- Pipeline interconnect commissioning - early February 2018
- Demonstration in NZE is ongoing with one 8.9L NZE ASL
- Generating RFS D3 RIN credit
- LCFS: Carbon Intensity (CI) 46 gCO_2e/MJ ; applying for negative CI

KORE Infrastructure

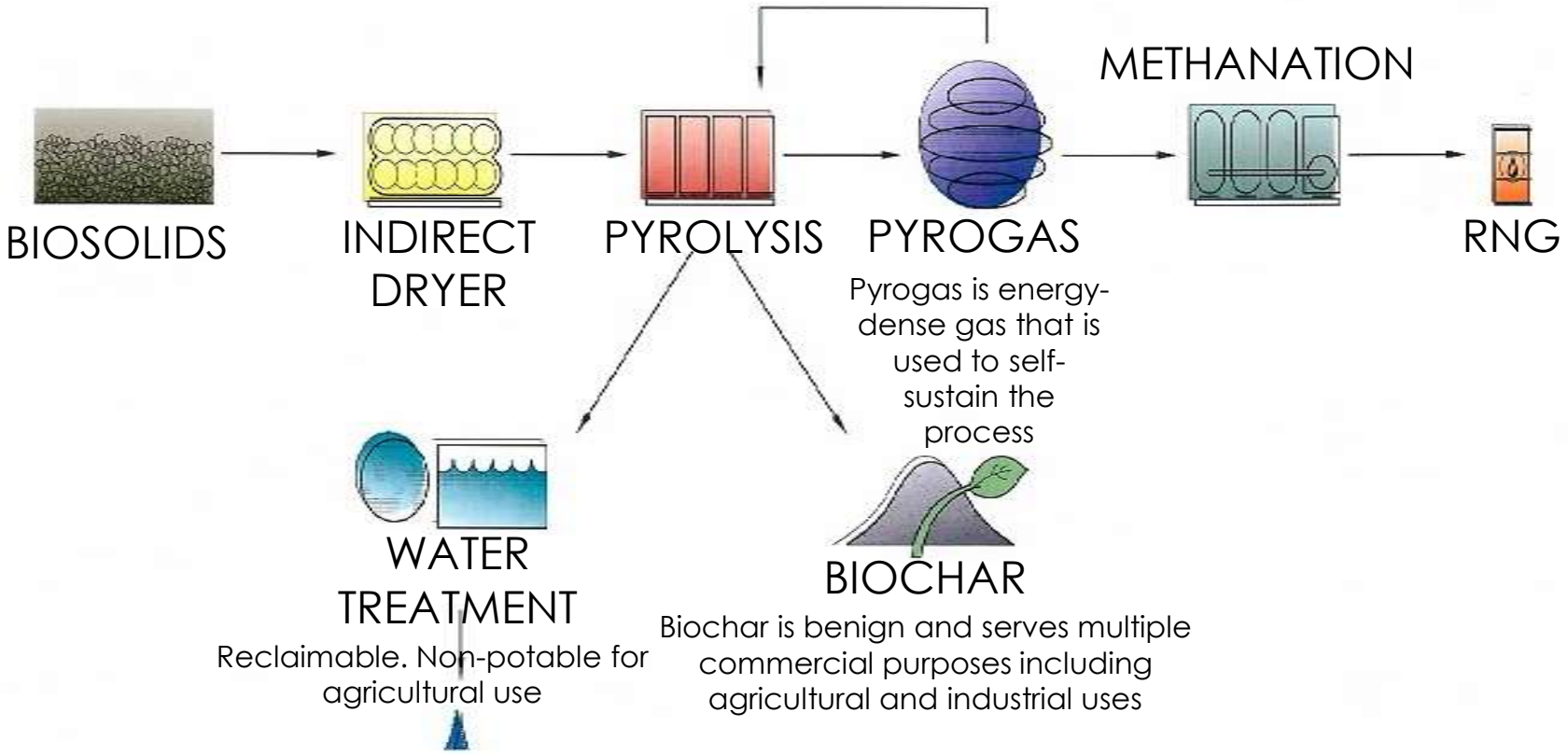
KORE Projects – Pyrolysis of BioSolids and low moisture Carbon based waste

- Technology Demonstration Project
  - SoCalGas and Kore funding partners
  - Purpose:
    - Demonstrate and troubleshoot Kore's full scale pyrolysis system
    - Assess the performance of various carbonaceous feedstocks
    - Test, analyze and quantify the syngas products
    - Assess syngas to H2 potential
    - Assess quality of RNG or H2 for potential pipeline injection
  - SoCalGas Olympic Blvd. property Los Angeles
  - Research permit from SCAQMD

KORE Projects

- Commercial RNG and NZE Demonstration - Rialto, CA
  - $1 MM CFF / $1.5MM of B.P. Settlement
  - Biosolids to RNG production via Pyrolysis
  - Feedstock from LACSD via truck
  - Indirect heating to reduce moisture content
  - Pyrogas and Syngas treatments
  - Gases reformed to pipeline quality RNG
  - RNG compressed for vehicle fuel or pipeline injection
  - Project pending completion of Technology Demo project

KORE – Waste to Energy Process



OntarioCNG – Multi-Fuel Station

OntarioCNG – Multi-Fuel Station

- Conventional Retail Fuel Station featuring:

  CNG/RNG, Hydrogen, Renewable Diesel, Electric Charging, E85

- OntarioCNG project included:
  - doubling of CNG delivery and storage capacity
  - securing RNG contract for 1,200,000 GGE/year; 2017 usage 626,416 GGE
  - RNG CI: -254.94gCO_2e/MJ ~ 70 lbs CO_2/GGE
  - RNG Source: Dairy Farm, Indiana
  - Annual GHG reduction estimate: for 1.2 MM GGE/Year
    - 35,000 MT/yr for RNG alone
    - 50,000 MT/yr based on equivalent displacement of gasoline or diesel with a CI of 100gCO_2e/MJ
  - LCFS Credit value Dec. 2017 $100/MT ~ $3,5000,000 or $2.90/GGE

UC Riverside - RENEWABLE NATURAL GAS TECHNOLOGY DEMONSTRATION PROJECT

UC RIVERSIDE UNIVERSITY OF CALIFORNIA | CE-CERT

- Evaluation of RNG production potentials via Thermochemical Conversion and Power-To-Gas (P2G) technologies
- Conduct technological and economic evaluations of high viability projects, including wells-to-wheels analysis of greenhouse gas (GHG) and criteria pollutant emissions and energy use
- Develop basis for the design of demonstration-scale projects and develop a roadmap that details the most feasible path towards commercialization, including technology choices, policy and regulatory barriers, timeline and financing strategies
- Conduct education & outreach to the public, policymakers and other stakeholders through conferences, communications, and media outlets, as well as technology demonstrations and publications.

UC Riverside – Preliminary Info

UC RIVERSIDE UNIVERSITY OF CALIFORNIA | CE-CERT

- Most Biomass in CA used in electricity generation
- Biomass to RNG is a significant opportunity for very low carbon fuel
- Excess renewable electricity (Solar, Wind) offers a Power –to-Gas opportunity to produce hydrogen or methane at very low cost .
  - Projected excess electricity: 12,000 GWh (2030) ~ 243 MM kg H_2
  - Projected H2 demand for FCEV is 70 MM kg/yr (2030)
- Thermochemical RNG production offers greater feedstock diversity and higher carbon conversion efficiencies
- Key technology options for RNG production are Gasification and Pyrolysis

UC Riverside – Preliminary Info

- Thermochemical processes necessary for meaningful RNG production
- Technology is not commercially mature
- Other issues/barriers: feedstock availability, collection and transportation costs, pretreatment, tar formation, gas cleanup, and high capital costs
- UCR focus:
  - feedstock pretreatment
  - gasification/pyrolysis technology development and demonstration
  - process optimization
  - gas conditioning and cleanup

Thank You and

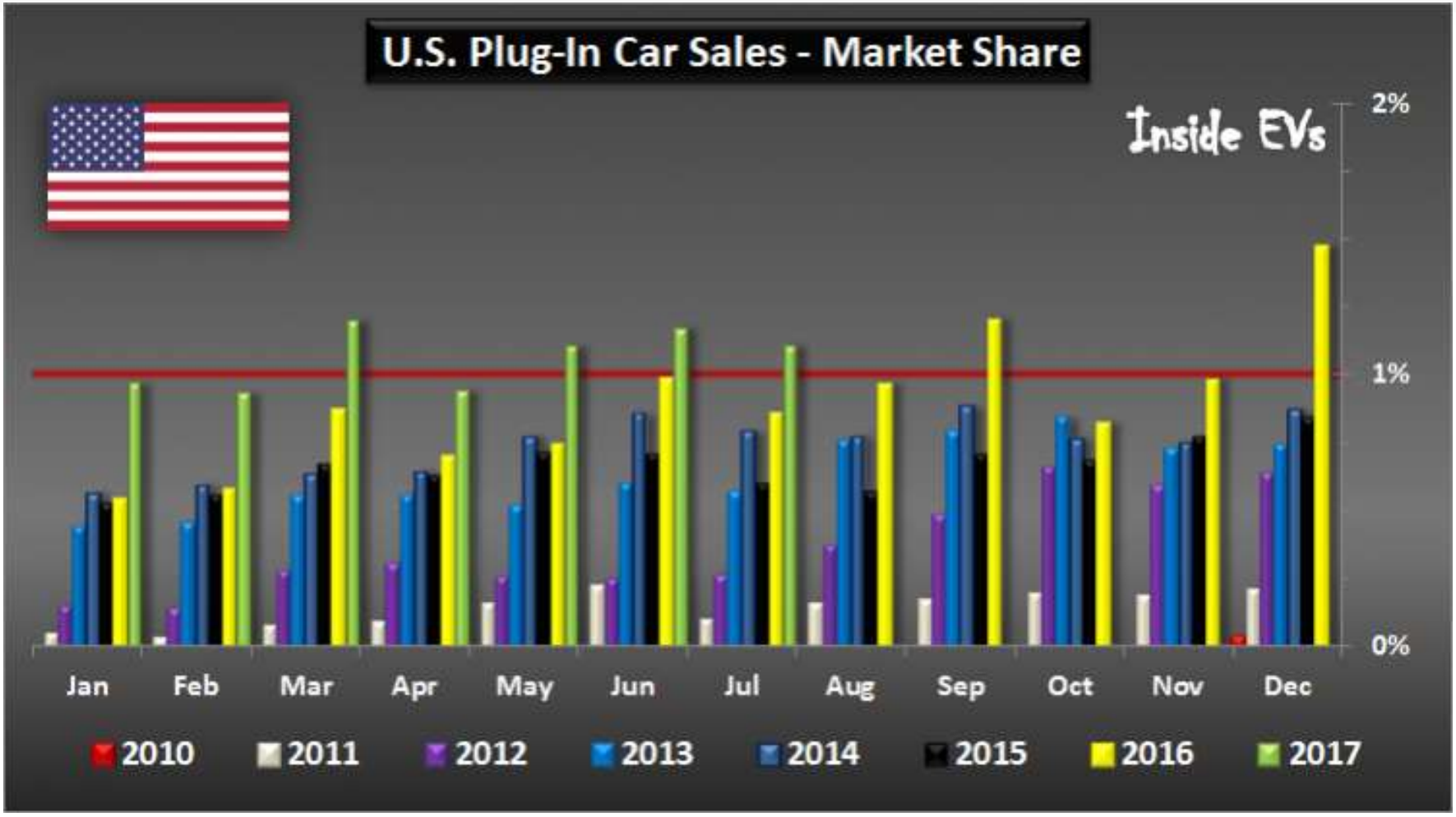
Think Renew

Clean Fuels Advisory Group Meeting
January 31, 2018

Commercial Fuel Cell and Battery Electric Vehicles

Lisa Mirisola
Program Supervisor
Science and Technology Advancement
South Coast Air Quality Management District

Increasing Plug-In car market share



Where Are EVs Taking Off?

While California remains the country's largest EV market in terms of cars on the road, it is no longer the fastest-growing. More states are encouraging EV driving by offering incentives such as tax credits, HOV lane access, utility rebates and special rate plans for EV charging.

Top 10 States

Total EVs in Operation

1. California
2. Georgia
3. Washington
4. Florida
5. Texas
6. New York
7. Michigan
8. Illinois
9. Oregon
10. New Jersey

EV Growth

1. Utah
2. Nevada
3. North Carolina
4. Colorado
5. Kansas
6. New Hampshire
7. Pennsylvania
8. Virginia
9. Florida
10. Arizona

Top 10 Metro Areas

Total EVs in Operation

1. Los Angeles
2. Bay Area
3. New York Metro
4. Atlanta
5. San Diego
6. Seattle
7. Chicago
8. Washington, D.C.
9. Detroit
10. Portland

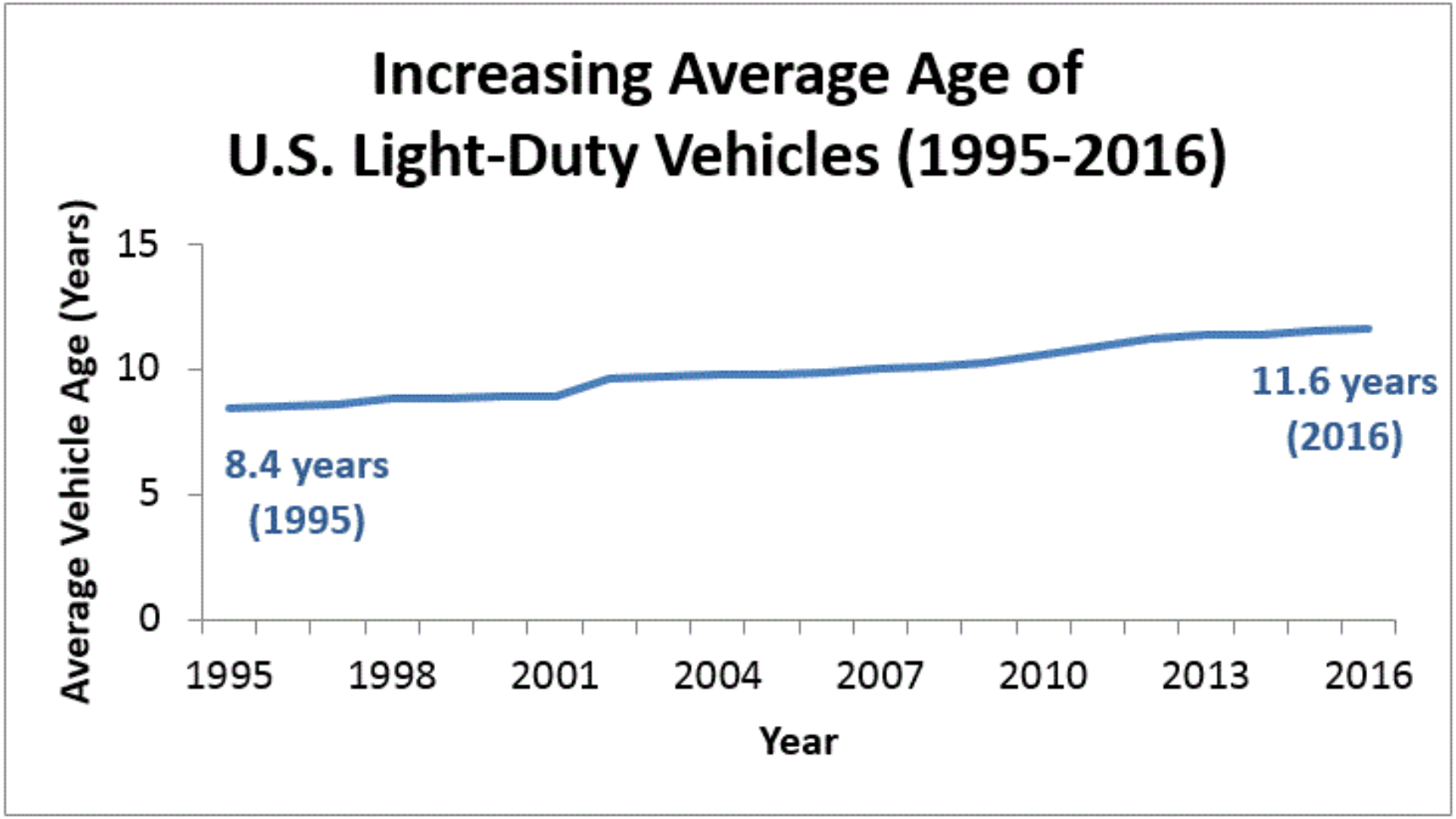
EV Growth

1. Las Vegas
2. Kansas City
3. Raleigh/Durham
4. Denver
5. Miami
6. Phoenix
7. Philadelphia
8. Portland
9. San Diego
10. Los Angeles

- Top 10 states for total EVs in operation
- Top 10 states for EV growth
- Top 10 metro areas for total EVs in operation
- Top 10 metro areas for EV growth

2017-US	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Tesla Model S*	900	1,750	3,450	1,125	1,620	2,350	1,425	2,150	4,860	1,120	1,335	4,975	27,060
Chevrolet Bolt EV	1,162	952	978	1,292	1,566	1,642	1,971	2,107	2,632	2,781	2,987	3,227	23,297
Tesla Model X*	750	800	2,750	715	1,730	2,200	1,650	1,575	3,120	850	1,875	3,300	21,315
Toyota Prius Prime	1,366	1,362	1,618	1,819	1,908	1,619	1,645	1,820	1,899	1,626	1,834	2,420	20,936
Chevrolet Volt	1,611	1,820	2,132	1,807	1,817	1,745	1,518	1,445	1,453	1,362	1,702	1,937	20,349
Nissan LEAF	772	1,037	1,478	1,063	1,392	1,506	1,283	1,154	1,055	213	175	102	11,230
Ford Fusion Energi	606	837	1,002	905	1,000	707	703	762	763	741	731	875	9,632
Ford C-Max Energi	473	639	662	720	950	936	844	705	683	569	523	436	8,140
BMW i3	382	318	703	516	506	567	601	504	538	686	283	672	6,276
Fiat 500e**	752	590	785	541	473	359	395	290	285	310	215	385	5,380
BMW X5 xDrive40e	262	275	397	291	433	488	463	317	333	329	929	832	5,349
Chrysler Pacifica Hybrid**	12	0	0	335	705	355	125	425	475	875	570	720	4,597
BMW 330e	129	144	365	260	475	496	387	409	329	307	477	363	4,141
BMW 530e				13	147	239	343	345	511	596	872	706	3,772
VW e-Golf	332	293	342	307	381	232	308	317	187	203	289	343	3,534
Audi A3 Sprtbk e-tron	387	400	414	301	294	324	218	129	85	17	38	270	2,877
Hyundai Sonata PHV**	190	175	295	280	220	255	205	185	190	210	135	195	2,535
Volvo XC90 T8 PHEV	96	83	103	145	146	202	174	265	236	174	204	368	2,196
Kia Soul EV	117	152	171	167	129	100	145	300	255	210	207	204	2,157
Ford Focus Electric	56	228	407	125	132	110	148	131	131	115	121	113	1,817
Tesla Model 3*							30	75	117	145	345	1,060	1,772
Porsche Cayenne S-E	177	121	126	185	174	195	160	178	124	73	38	23	1,574
Kia Optima PHV	10	61	70	86	85	78	130	182	228	235	213	134	1,512
Honda Clarity BEV							34	15	52	34	459	527	1,121
Honda Clarity PHEV											5	898	903
Mercedes C350e	210	51	17	3	7	0	112	212	126	49	16	14	817
Mercedes B250e	53	56	50	66	46	46	81	58	87	59	31	111	744
BMW 740e	18	35	42	123	33	52	80	39	43	55	120	67	707
Mercedes S550e	55	51	60	81	83	81	124	32	35	16	22	26	666
smart ED	15	22	13	3	1	3	0	94	123	73	68	129	544
Volvo XC60 PHEV							13	65	97	100	82	174	531
BMW i8	50	58	49	23	18	22	55	29	27	33	44	80	488
Mini Countryman S E PHV						10	75	86	80	56	96	72	475
Mercedes GLE 550e	52	59	47	36	33	41	27	23	14	8	41	82	463
Hyundai IONIQ Electric			5	19	75	58	43	66	36	28	23	79	432
Cadillac CT6 PHV				8	16	20	22	23	27	27	29	35	207
Volvo S90 T8 PHEV									5	28	32	52	117
Mitsu Outlander PHEV												99	99
Chevrolet Spark EV	4	4	3	1	0	1	1	0	0	0	7	2	23
Porsche Panamera S-E	2	1	3	2	1	0	0	1	1	2	5	0	18
Cadillac ELR	3	0	2	2	0	7	2	1	0	0	0	0	17
Mitsubishi i-MiEV	0	1	3	2	0	0	0	0	0	0	0	0	6
InsideEVs	11,004	12,375	18,542	13,367	16,596	17,046	15,540	16,514	21,242	14,315	17,178	26,107	199,826
2016 Results	6,221	7,763	13,857	10,531	11,467	14,863	13,067	14,592	17,224	11,007	13,237	24,785	158,614
Worldwide*	41,372	53,561	94,650	71,762	91,417	102,130	92,835	103,408	121,323	121,720	145,810		1,039,988

Reduced Vehicle Turnover

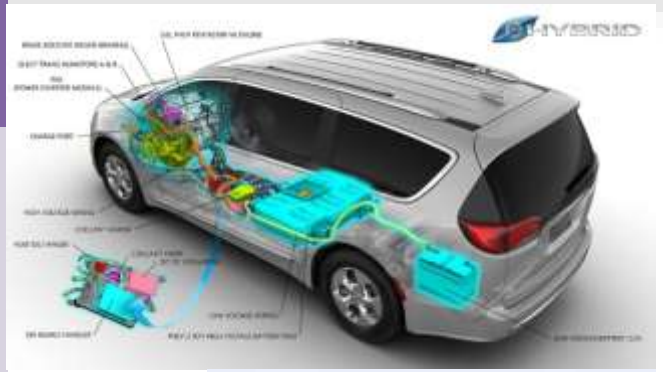


SCAQMD Demonstration Vehicles

Vehicle Type	Demonstration Vehicles In Use
Plug-In Hybrid	
2013+2014+2016+2017 Chevy Volt	3 + 2 + 1 +1
2014 Ford Fusion ENERGI	2
2014 VIA PHEV Chevy vans	2
2018 Honda Clarity Plug-In Hybrid	1 (ordered)
Battery Electric	
2017 Chevrolet Bolt EV	2
2018 Honda Clarity BEV	1 (ordered)
Fuel Cell	
2015 Hyundai Tucson FCEV	1
2016 Toyota Mirai	2
2017 Honda Clarity Fuel Cell	3
2018 Honda Clarity Fuel Cell	2 (ordered)

SCAQMD Demonstration Vehicles 2018-2019 Potential Additions

Vehicle Type	Potential Additions
Plug-In Hybrid	
2018 Chrysler Pacifica Hybrid	1-2
Battery Electric	
2018 Hyundai Ionic	1-2
2018 Nissan Leaf	1-2
Fuel Cell	
2018 Toyota Mirai	1-2
2018 Hyundai NEXO FCEV	1-2
2019 Mercedes GLC F-Cell EQ	1-2



SCAQMD's Clean Air Choices Program

- Features the cleanest new retail passenger vehicles
- Part of the AQMD website http://www.cleanairchoices.org.

CleanAir CHOICES

- Out of 35 models listed for 2018
  - 18 Zero Emission (2 hydrogen fuel cell & 16 battery electric)
  - 17 Advanced Technology Partial (or new Transitional) Zero Emission plug-in gasoline hybrid

  Partial Zero Emission gasoline only-fueled (PZEVs) and gasoline only-fueled hybrids that don't plug in (some AT-PZEVs) no longer get partial ZEV credit
- Outreach Efforts with clean and efficient vehicles, and highlight new infrastructure

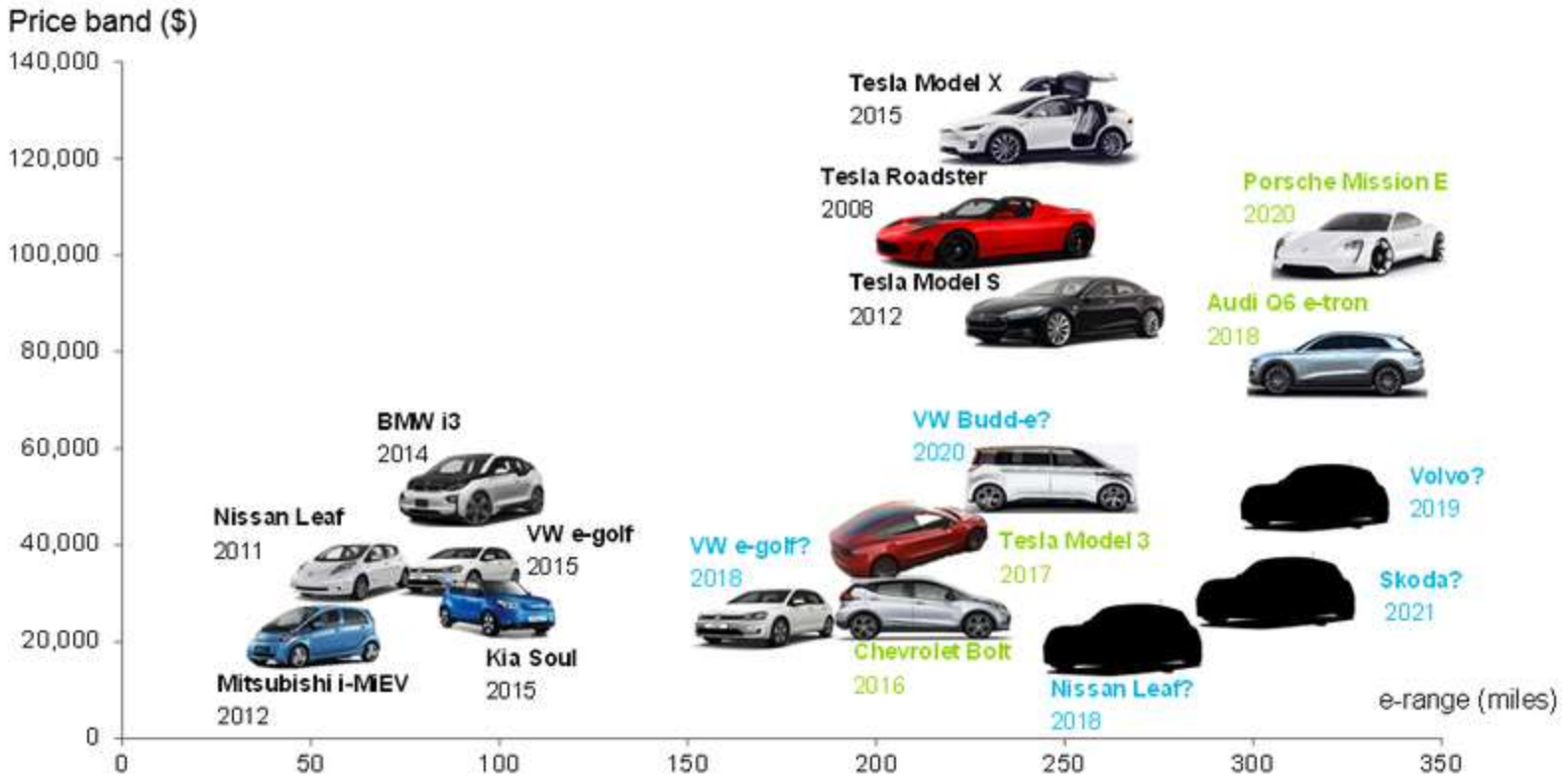
Federal & CA Current Incentives

- $2,500 – $7,500 PEV federal tax credit
  $4,000 FCV federal tax credit expired
- Up to $7,000* through CA Clean Vehicle Rebate
  8-year funding for CVRP from cap & trade fund**
- CA HOV lane access continues to 1/1/22;
  choose CVRP or carpool access, subject to income limits (except fuel cell vehicles)
- CA ZEV Action Plan
  5 million ZEVs in California by 2030 with $2.5B EO**
- 8-State ZEV Action Plan to sell 3.3M ZEVs by 2025
- CEC funding for Infrastructure; EVSE & H2
- Off-peak (TOU) electric rates

*for qualifying fuel cell vehicles, depending on income

**** Executive Order B-48-18 issued January 26, 2018**

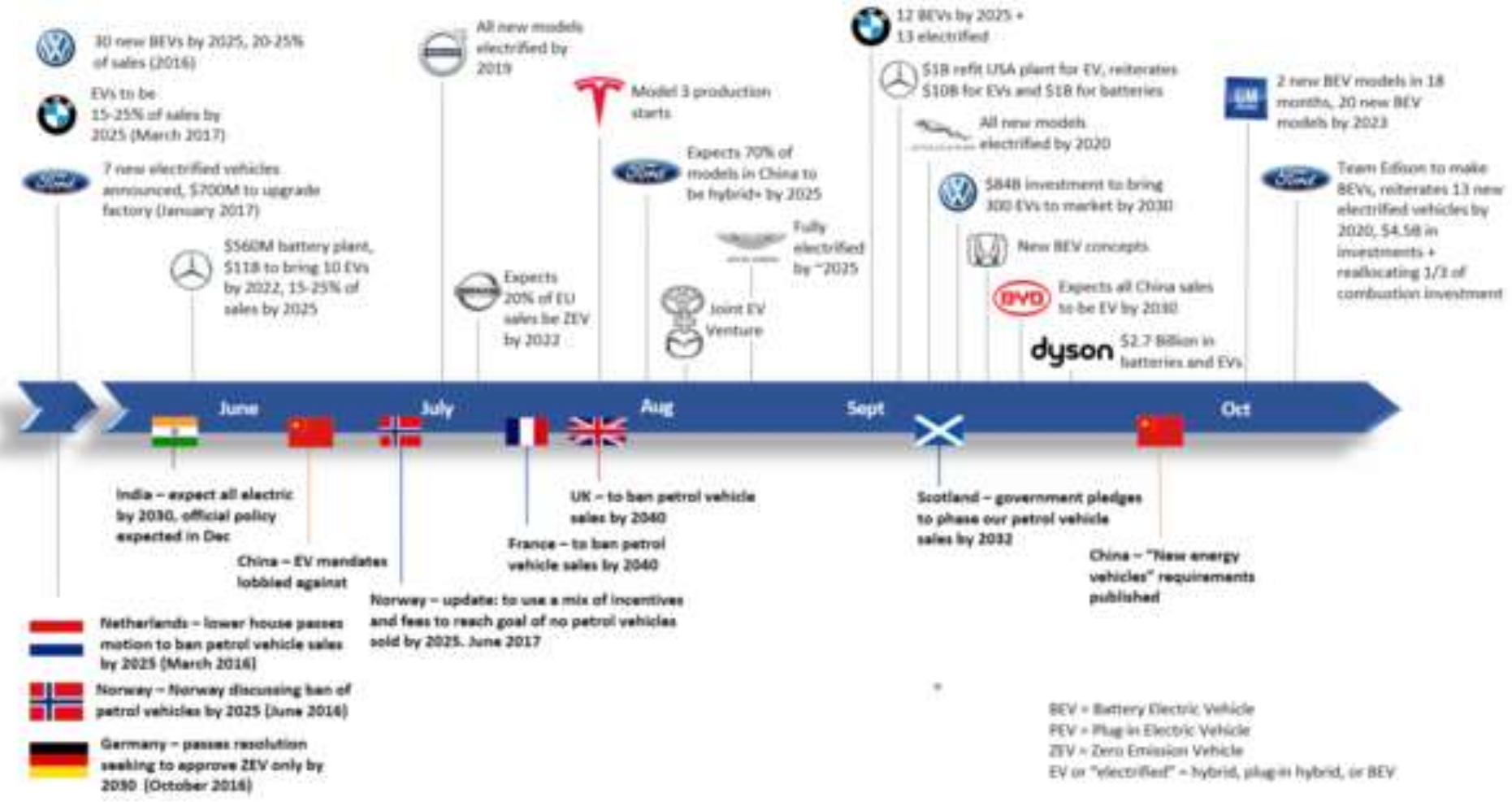
2015 Future US BEVs



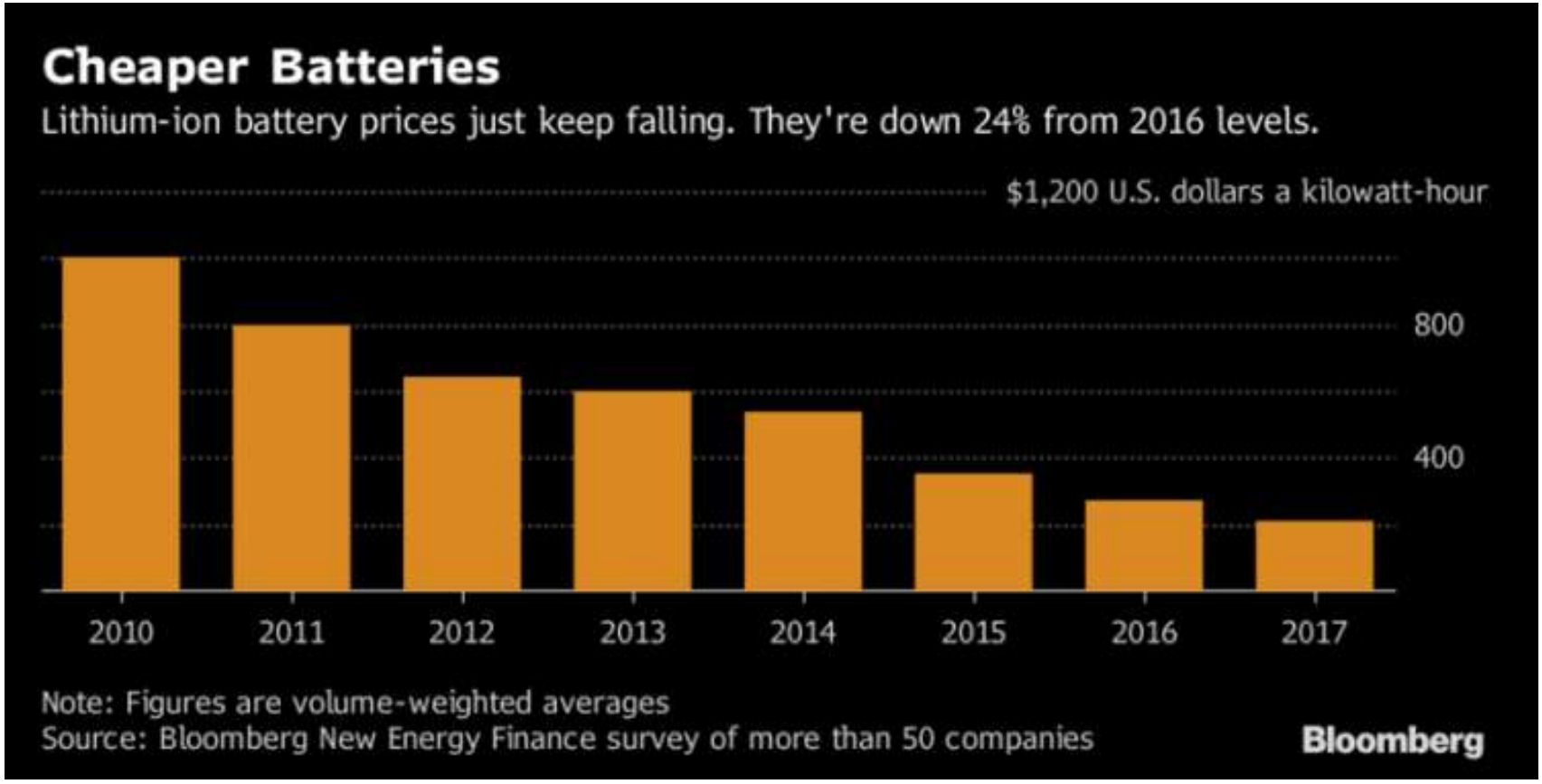
Note: Selected US battery electric vehicles (BEV) only. Positions are representative and do not indicate exact prices or range. Back labels = currently available, green labels = forthcoming models with specifications and timeline released. Blue labels = announced but limited details confirmed. Range is based on manufacturers statements, not on any specific test cycle.

Bloomberg
NEW ENERGY FINANCE

2017 Automakers Future EV Announcements

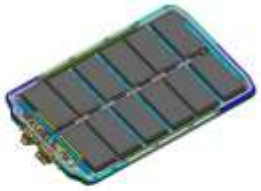


Cheaper Batteries



General Motors Progress & Plans

Cell Cost
$145/kWhr



Cell Cost
$<$100/kWhr

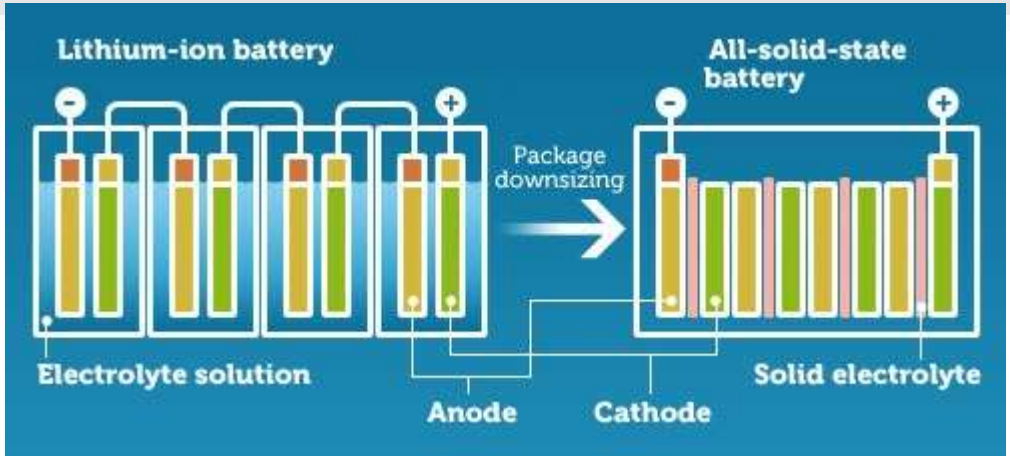
ALTERNATIVE PROPULSION
MARKET PERSPECTIVE

FUEL CELL ELECTRIC VEHICLES
- More favorable ZEV treatment
- More "conventional" fueling experience
- Longer Range – 300-450 miles
- Larger Vehicles
- Key Partner: Honda

BATTERY ELECTRIC VEHICLES
- Declining costs, increasing volumes – battery cells and packs
- Increasing range, decreasing range and infrastructure anxiety
- Lowest "Fuel" cost per mile versus gas and hydrogen
- Key Partner: LG

BATTERY & FUEL CELL TECHNOLOGY – Both Have Roles to Play within GM's Portfolio

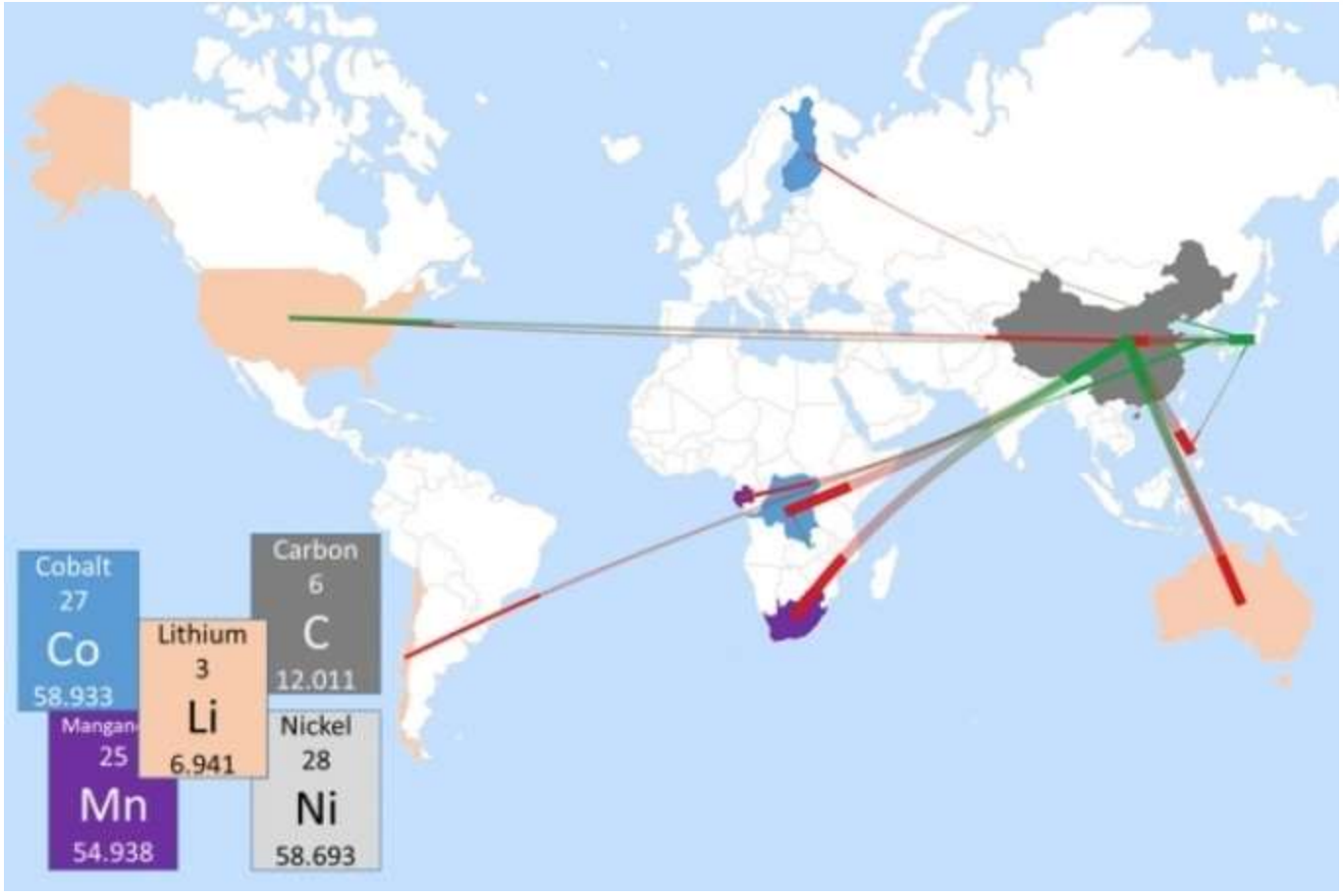
Toyota Plans



Solid state battery size reduction - Toyota 2022

2018 Toyota Fine Comfort Ride fuel cell concept

Materials Availability



Lithium battery import-export study by MIT

Additional Elements

Mobility Investments

LEVEL	NAME	STEERING, ACCELERATION & DECELERATION	MONITORING OF DRIVING ENVIRONMENT	FALLBACK PERFORMANCE OF DYNAMIC DRIVING TASK
Zero	No automation	Human	Human	Human
One	Driver assistance	Human and system	Human	Human
Two	Partial automation	System	Human	Human
Three	Conditional automation	System	System	Human
Four	High automation	System	System	System
Five	Full automation	System	System	System

Source: SAE International and J3016
Note: Level 5 has system capability in all driving modes (e.g., expressway merging, high-speed cruising, low-speed traffic jam, etc.) vs. some driving modes for levels 1-4

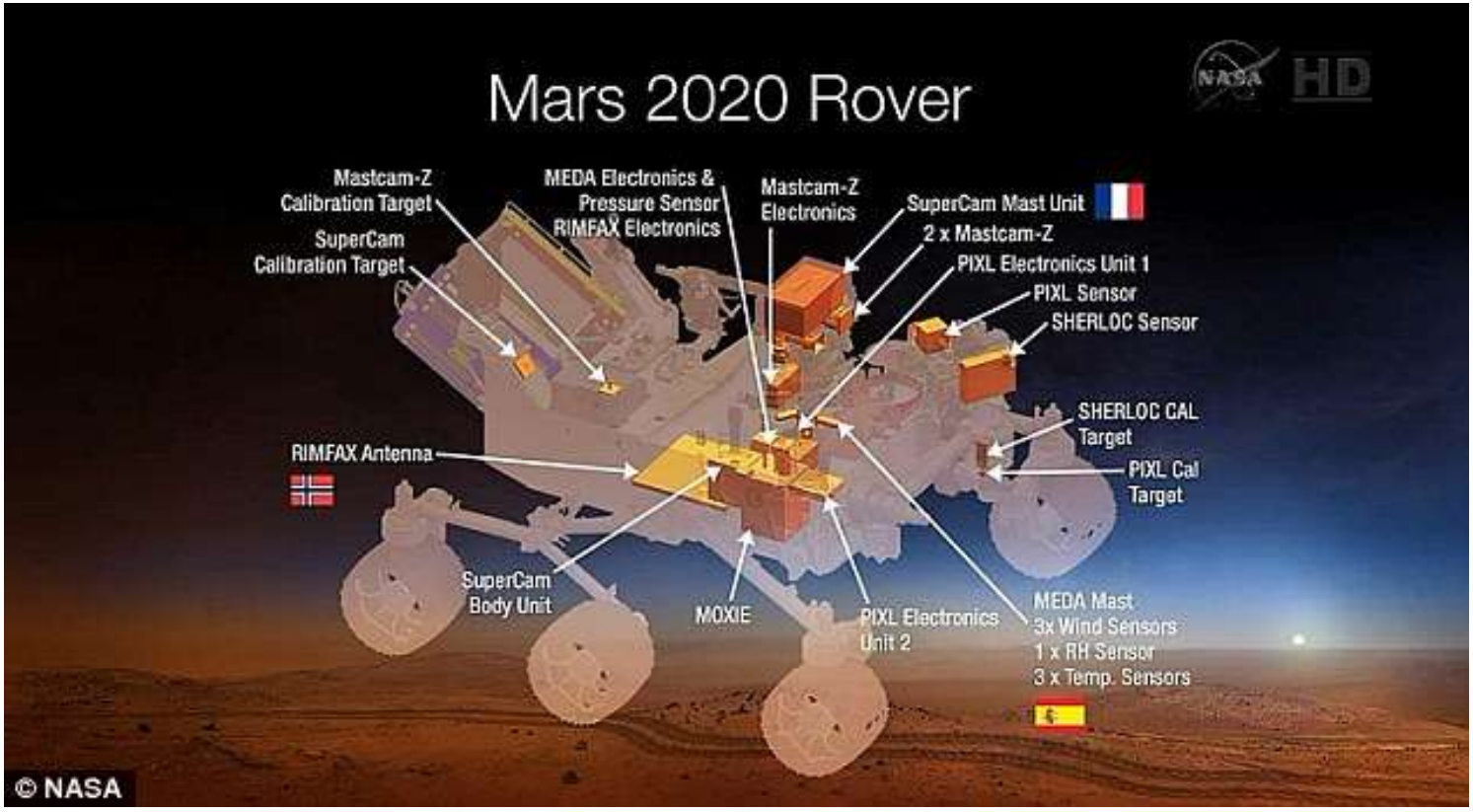
Bloomberg

Increasing Levels of Automation

Photos and data: Chevrolet

PlugInConnect.com

Technology Transfer



Continued Research & Development

Hydrogen Fueling protocol J2601 testing with HySTEP equipment (trailer)

Versatile Auxiliary Power demonstrations with EPRI, SCE, LADWP, municipalities

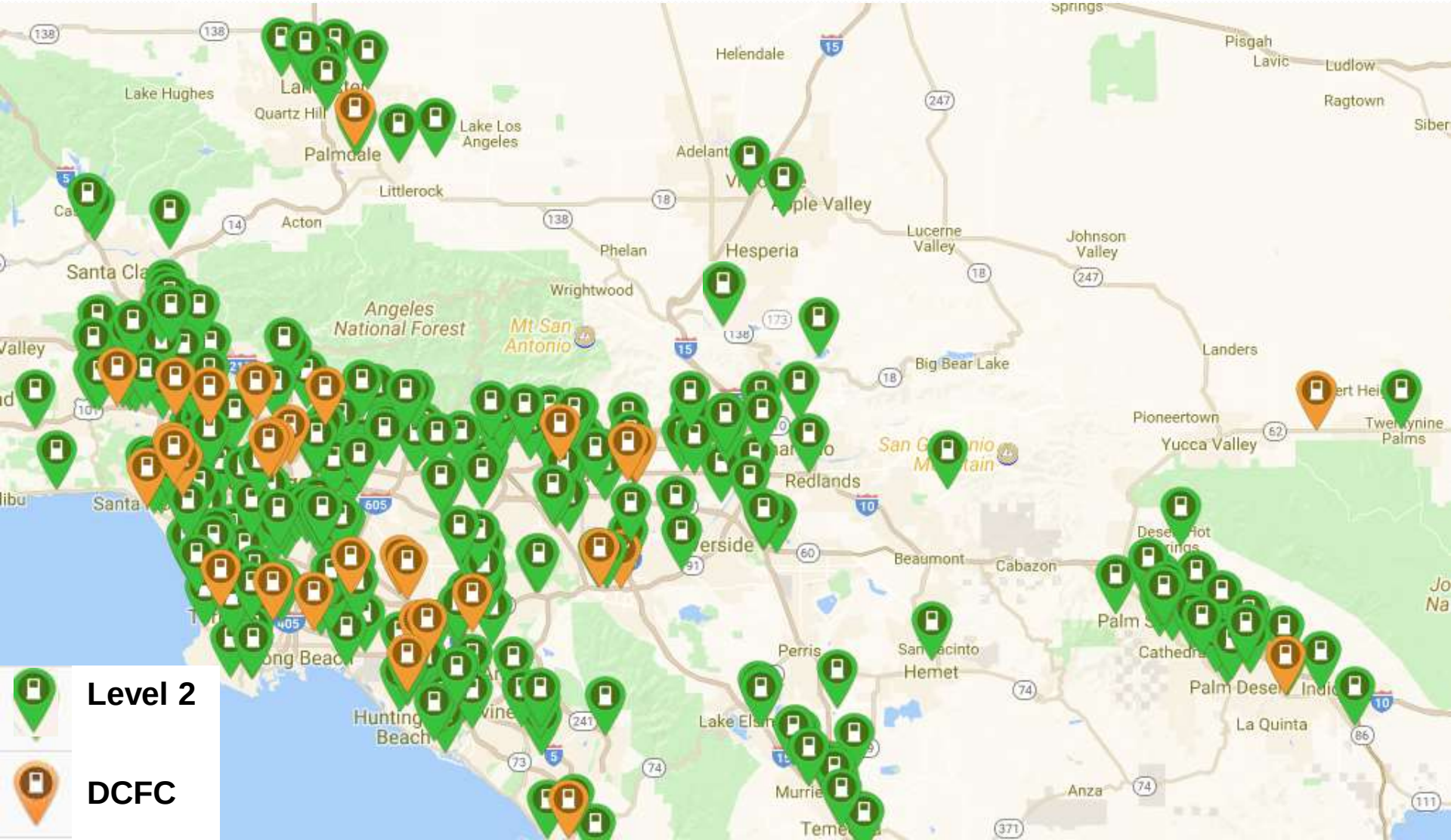
Hydrogen and Electric Vehicle Charging Clean Fuels Retreat January 31, 2018

Patricia Kwon
Technology Advancement Office

EVSE Deployment Efforts

- DC Fast Charging – 17 site network
  CEC $1.22M
- SoCalEV – 321 Level 2 for workplace and destination charging
  CEC $840k
- SCAQMD Workplace Charging – 92 Level 2 chargers
- Residential EV Charger Rebate Program
  $500k SCAQMD, $500k MSRC

Level 2 and DC Fast Charging Map



DCFC Network

- 17 DCFC sites in South Coast Air Basin
- EVgo network provider, Clean Fuel Connection installer, Three Squares education outreach, UCLA Luskin Center site selection modeling

DCFC Network

- Seven sites completed, remaining sites by June 2018
- MOA with LADWP, LADOT for Los Angeles city sites
- Sites from Calabasas to Coachella Valley
- Future sites in Inland Empire, transit centers
- Develop best practices for DC fast charging
- More info at www.socalfast.com

SoCalEV Ready Program

- 321 Level 2 chargers installed April 2016
- All four counties: LA Zoo, Lake Elsinore Diamond Stadium, Getty Center/Villa, CA State Parks, Disneyland
- Best practices siting, deployment for Level 2 charging


Golden Springs Dr
Solar Carport
CC8 Parking Lot
Front Lobby/
Guest Parking Area
Upper Park
Copley Dr
Copley Dr

SCAQMD Workplace Charging

- 92 Level 2 chargers including 6 ADA
- BTC chargers on Greenlots network
- Installation completed March 2017
- EV charging for staff, public, fleet
- Supports Rule 2202 for large workplaces
- Develop best practices on workplace charging

Software Capabilities

- Payment by phone app or RFID
- Text notification to drivers when charging initiated, stopped, or chargers become available
- Automatic escalation process for repairs
- OCPP, SEP, OpenADR compliant

Demand Response Capabilities

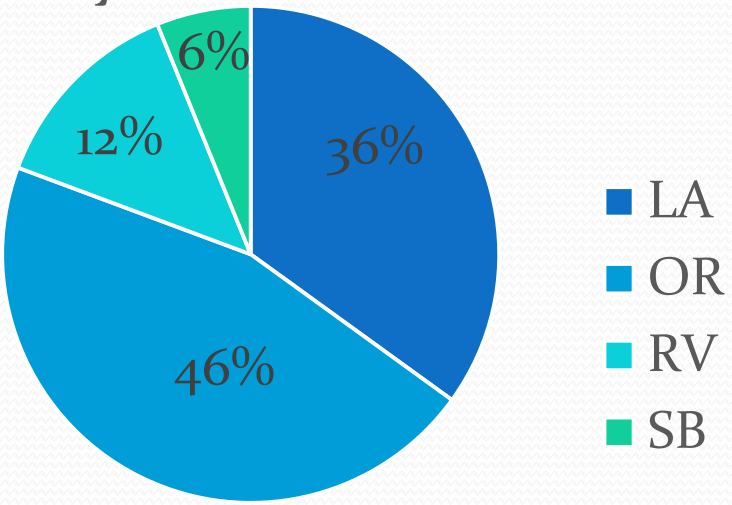
- DR integration between hardware and software
- Wifi network for chargers to transmit to Greenlots server
- Can ramp down chargers based on DR events/signals

Residential EV Charger Rebate

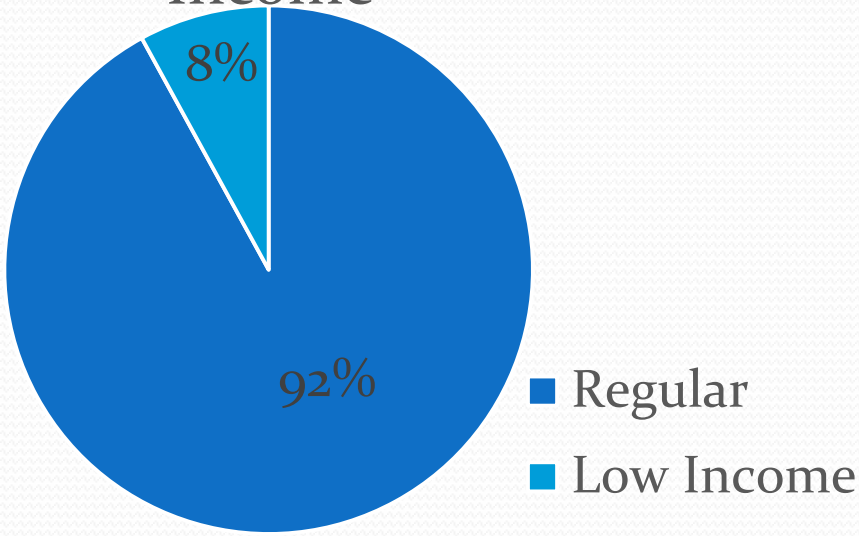
- $250 or $500 (low income) rebate towards hardware
- 326 rebates awarded
- Residential chargers cost $400 - $800
- BEV rebates more popular
- Popular charger models: ChargePoint, Clipper Creek, Juicebox

EV Charger Rebate Statistics

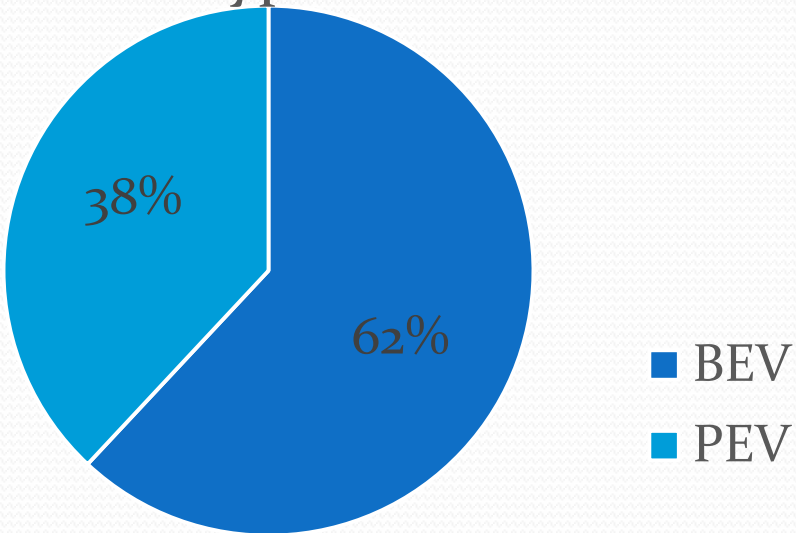
County



Income

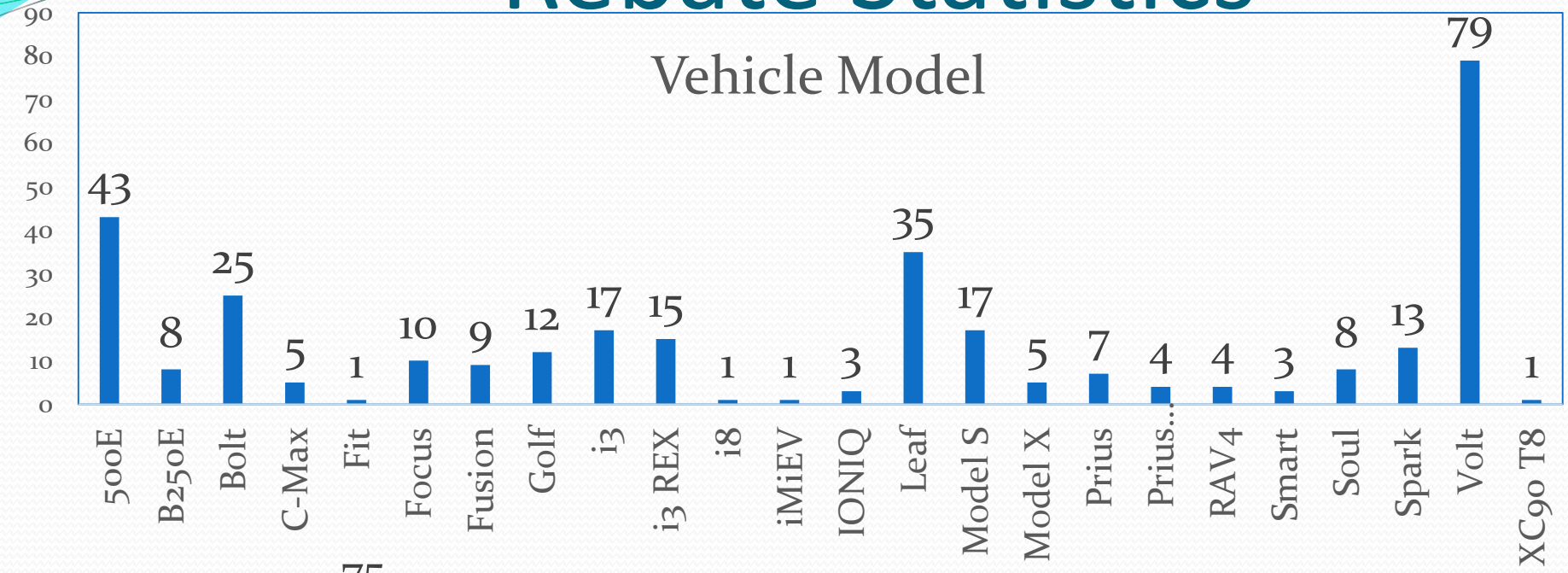


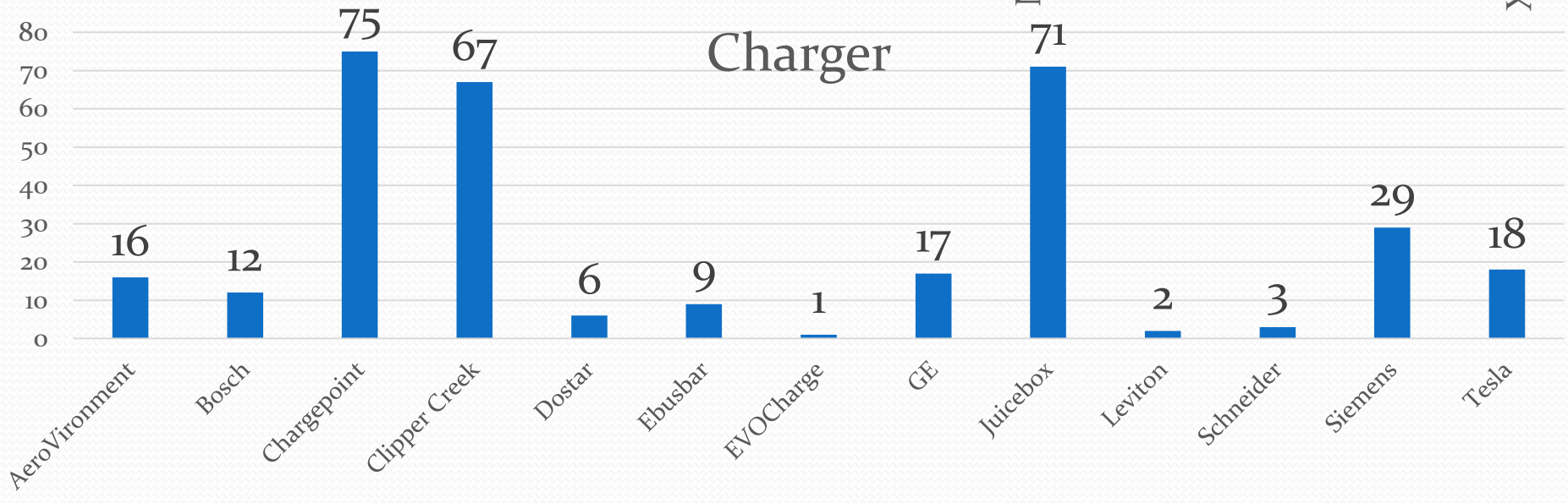
Vehicle Type



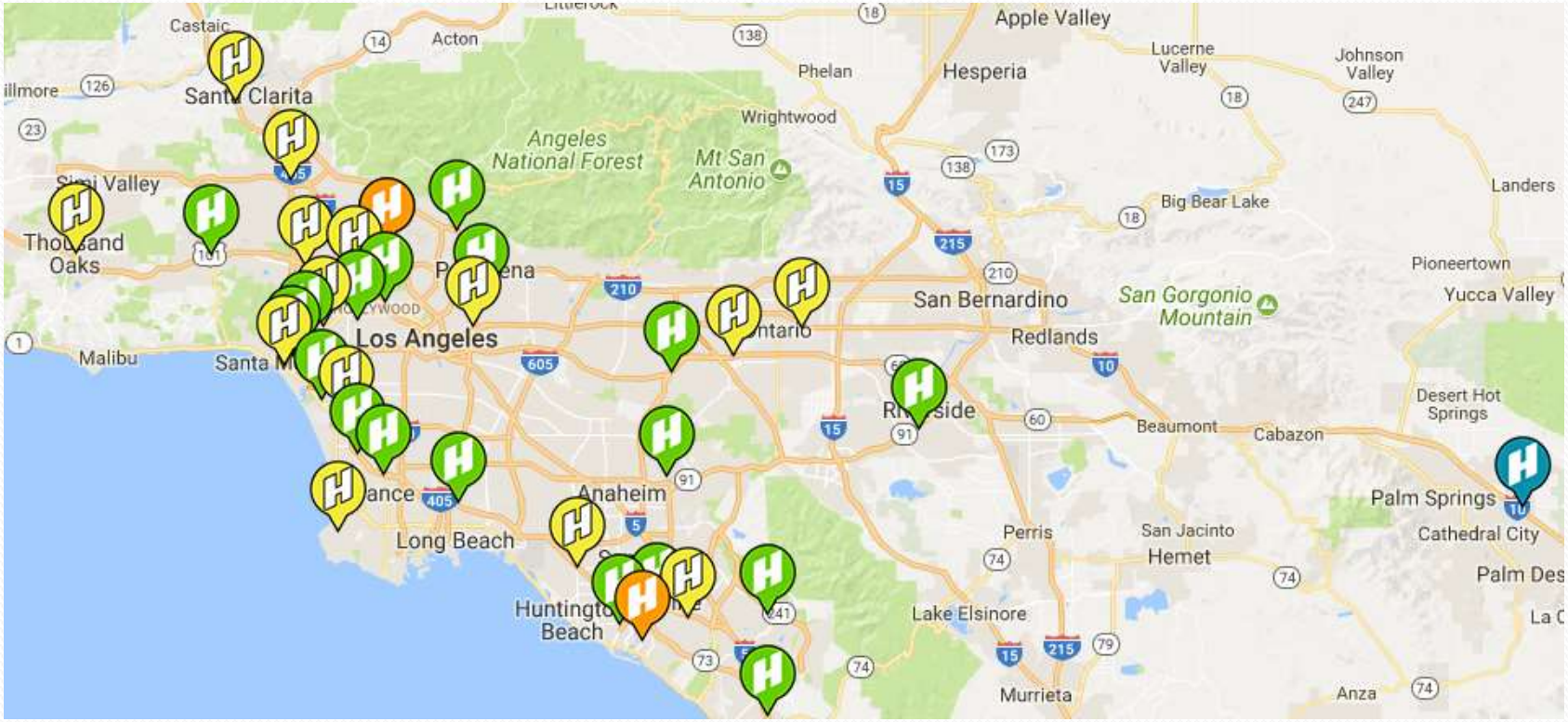
326 EV Rebates Processed 12/21/17

Rebate Statistics





South Coast Hydrogen Stations



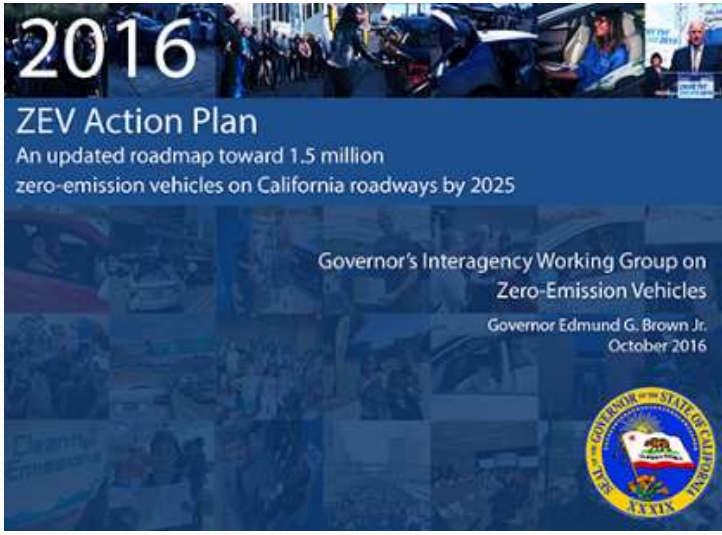
- 18 retail hydrogen stations
- 2 non-retail hydrogen stations
- 14 stations in development

Medium & Heavy Duty Infrastructure

- Infrastructure challenges
- Difficult to co-locate with light duty vehicles
- Refueling protocol for heavy duty vehicles not yet standardized
  - SAE J2601 for light and medium duty vehicles
  - SAE J2601-2 TIR for heavy duty vehicles (performance based)
- Regulatory approval for sale of hydrogen needed
- Only demonstration, not permanent stations

Policy Guidance & Regulation

- CA Governor's Executive Order 1/26/18
  - $2.5B eight year investment plan
  - 5M ZEVs by 2030
  - 200 hydrogen fueling stations by 2025
  - 250,000 EV chargers by 2025
  - 10,000 DC fast chargers by 2025
- CA 2016 Sustainable Freight Action Plan
- CaFCP 2016 Medium & Heavy Duty Fuel Cell Truck Action Plan



Next Steps

- Develop SAE J2601-2 TIR to full standard protocol
- Address gaps in fueling protocols and standards
- Consolidate funding of heavy duty trucks + infrastructure so stations have higher demand and throughput to reduce costs ($/ton or $/kg)



Enhanced Fleet Modernization Program

Clean Fuels Advisory Group

Lori Berard

January 31, 2018

Background

Enhanced Fleet Modernization Program (EFMP)

- Voluntary retirement & replacement of light- and medium-duty vehicles
- Vouchers can be used to obtain:
  - Replacement vehicle 8 years old & newer; or
  - Alternative transportation card (i.e. transit passes, Uber, Lyft)

EFMP Focus

- Community outreach
  - Lower-income consumers
  - Disadvantaged communities

- Tiered funding based on household income
- Larger incentive amounts for advanced technology replacement vehicles

- Additional incentives for residents living in disadvantaged communities

Incentive Levels

Income Eligibility	Conventional		Hybrid		Plug-In Hybrid & Zero-Emission[3,4]
	20+ MPG[2]	35+ MPG	20+ MPG	35+ MPG	
Low	$4,000	$4,500	$4,000 or $6,500	$4,500 or $7,000	$4,500 or $9,500
Moderate	-----	$3,500	-----	$3,500 or $5,000	$3,500 or $7,500
Above Moderate	-----	-----	-----	-----	$2,500 or $5,500

1 Option is available to receive transportation vouchers valued at $2,500 to $4,500 in lieu of obtaining replacement vehicles.

2 MPG threshold varies by vehicle model year.

3 Zero-emission vehicles include battery electric vehicles (BEVs) and fuel cell vehicles.

4 BEVs are eligible for an additional incentive up to $2,000 for the installation of electric vehicle charging equipment.

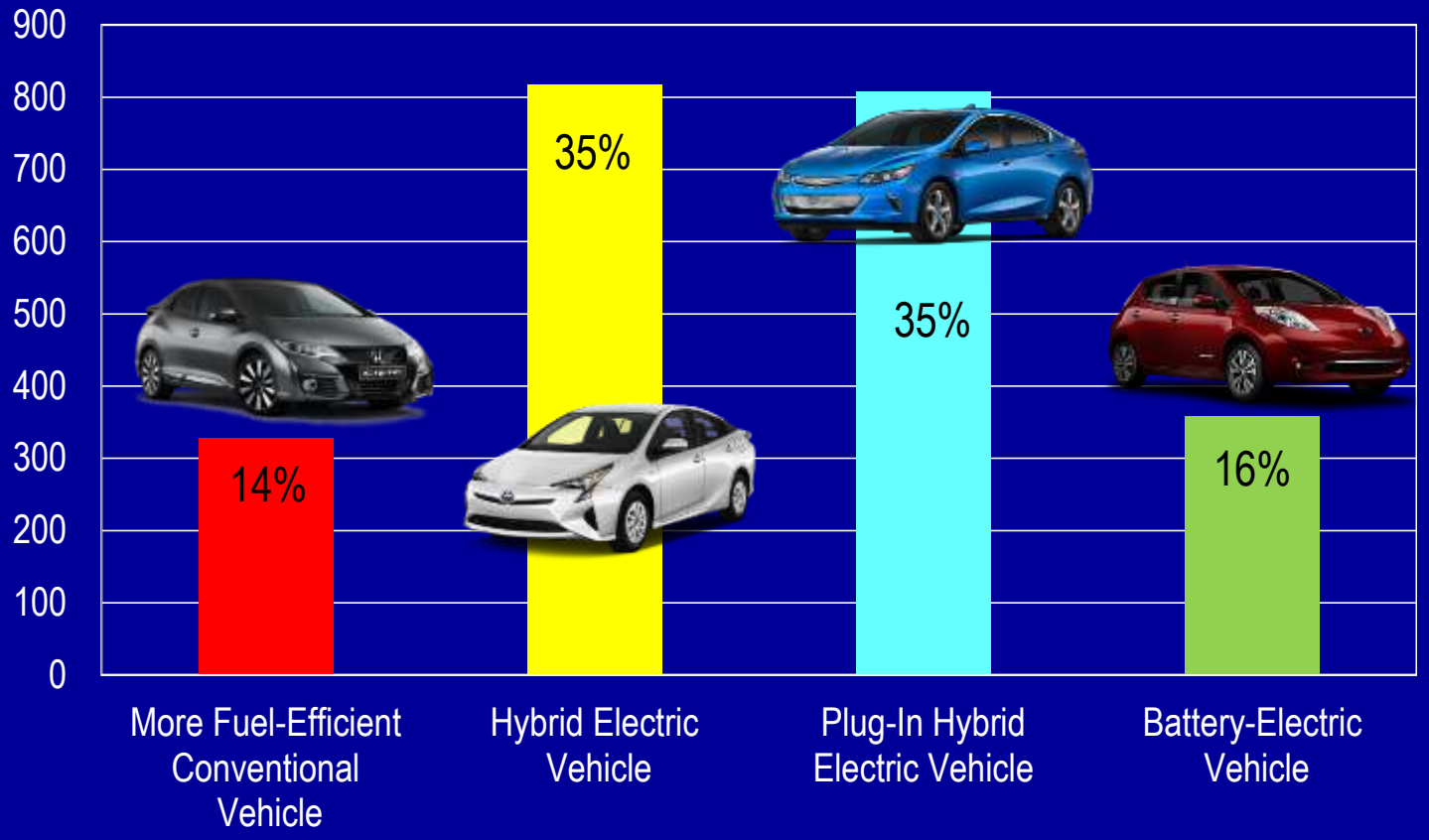
EFMP Implementation in the South Coast AQMD

- "Replace Your Ride" Program
- "Case managers" assist each participant
- Consumer protections provided
- 55 Participating Automobile Dealerships

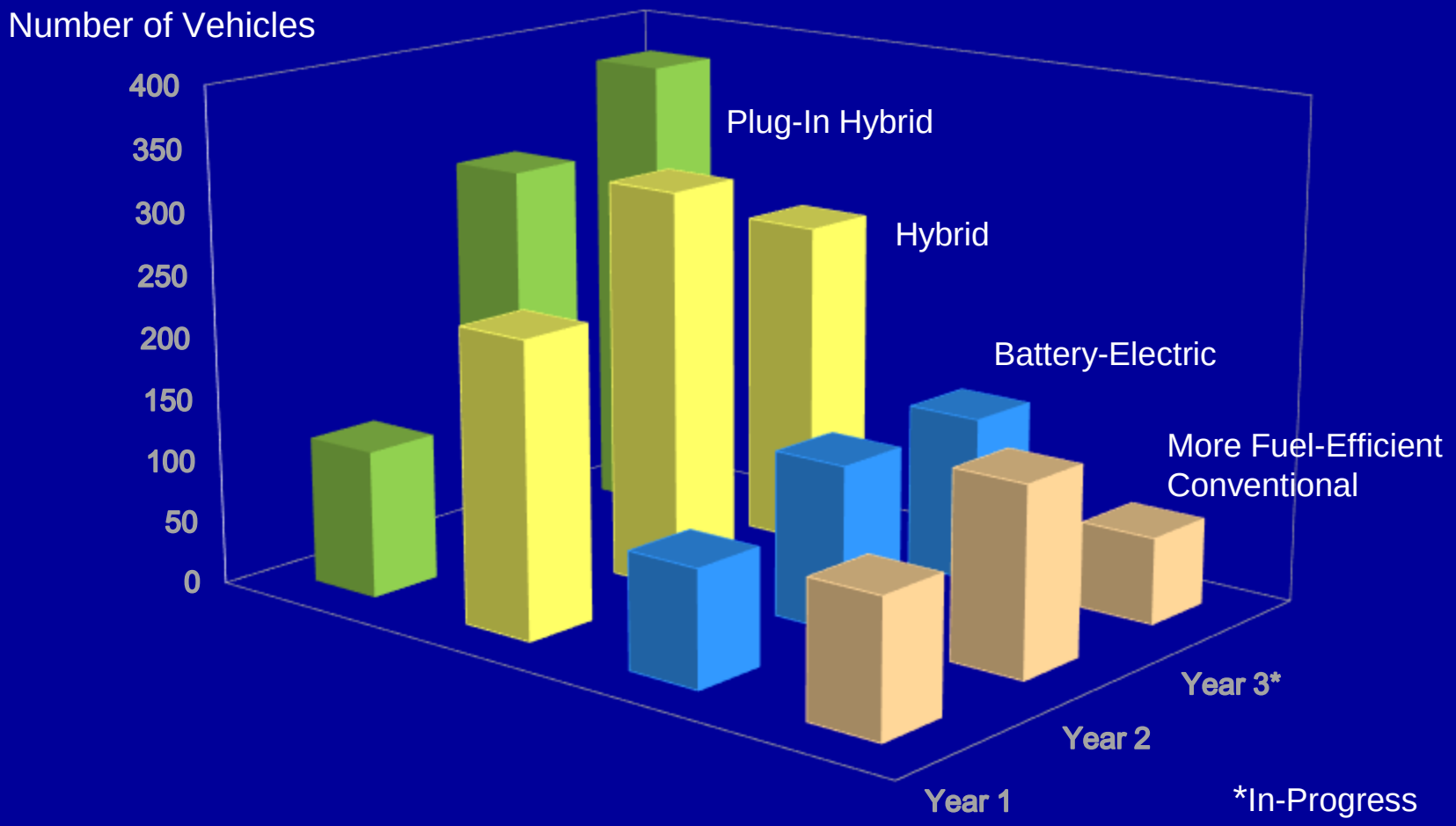
Statistics on Approved Vouchers
(as of January 2018)

- Over 2,300 Vehicles Replaced
- 94% - Disadvantaged communities
- 83% Receive Plus-Up funding
- Income Level Participation
  - 86% ≤ 225% federal poverty level
  - 10% ≤ 300% federal poverty level
  - 4% ≤ 400% federal poverty level
- Avg Fuel Economy Improvement – 40 mpg

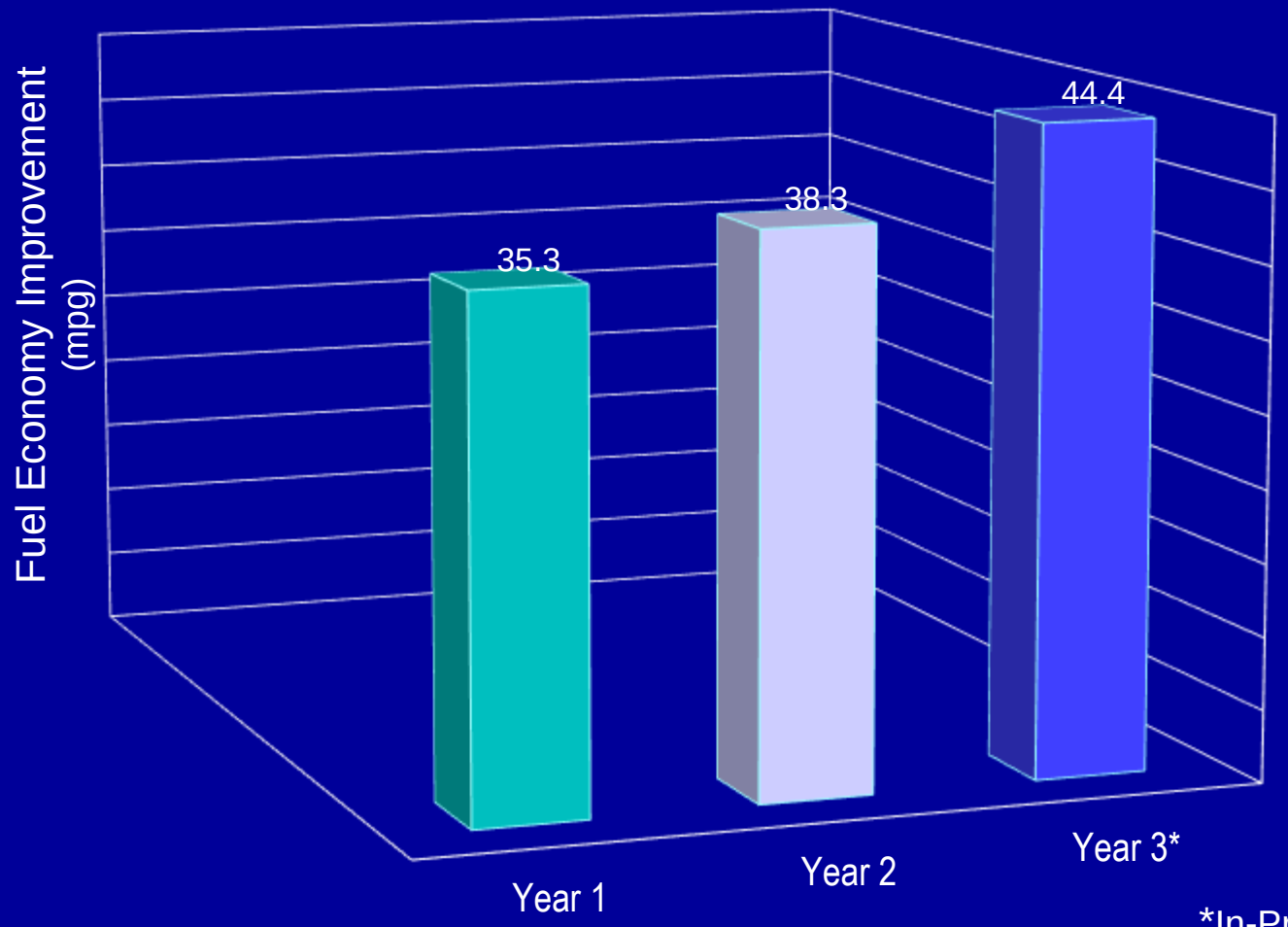
Replacement Vehicle Types



Replacement Vehicle Types by Year

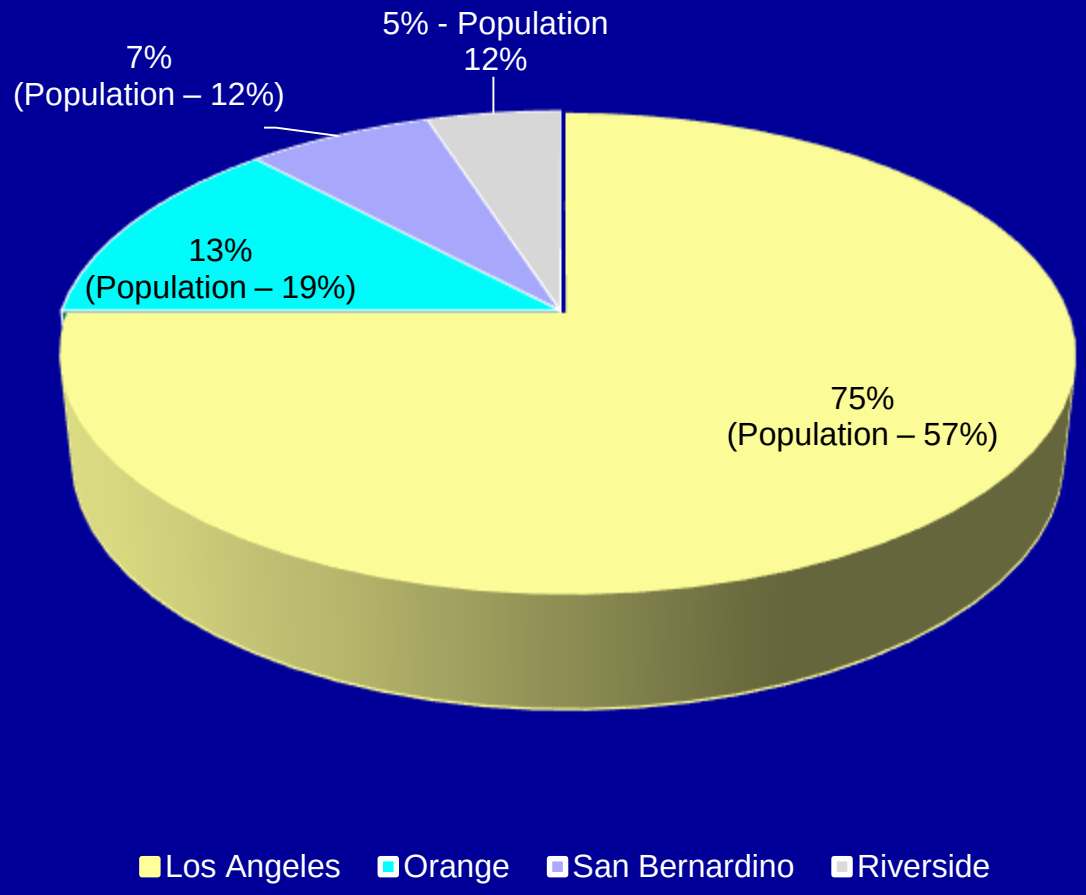


FUEL ECONOMY IMPROVEMENT

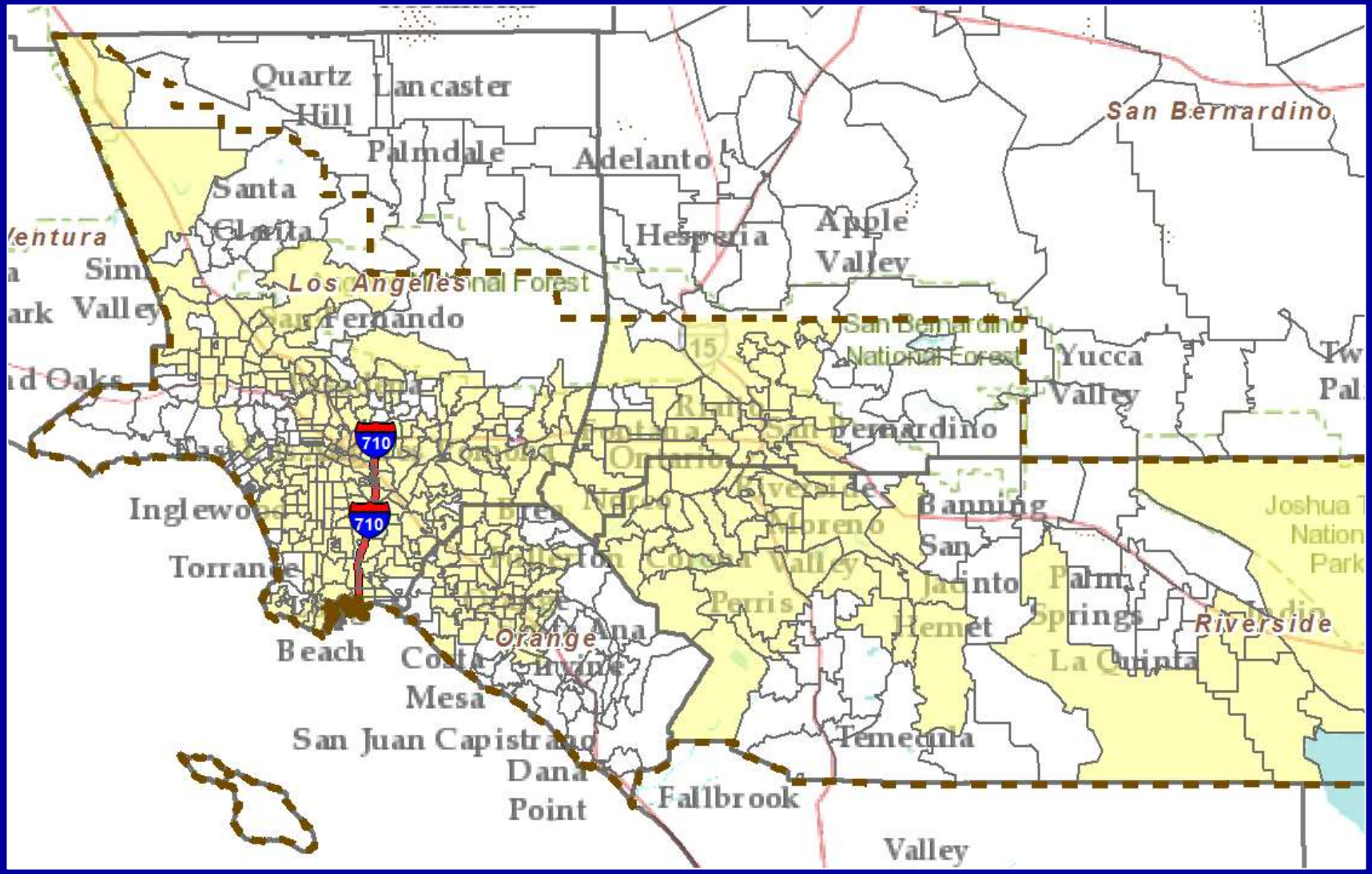


*In-Progress

PARTICIPANT DISTRIBUTION BY COUNTY



Disadvantaged Communities in the SCAQMD



Improved Website

- Website - replaceyourride.com
  - Improved participant interface with tracking of application status and other features
  - Streamlining of internal process in-progress
- Call Center (844) 797-2223
  - Closer coordination with AQMD staff to improve call center staff's ability to respond to inquiries, workshops, & emission testing events

Moving Forward

Continue to:

- Improve website
- Increase number of case managers working directly with participants
- Hold workshops to pre-qualify participants
- Enhance communication / training of participating automobile dealerships
- Work in establishing more dismantler locations

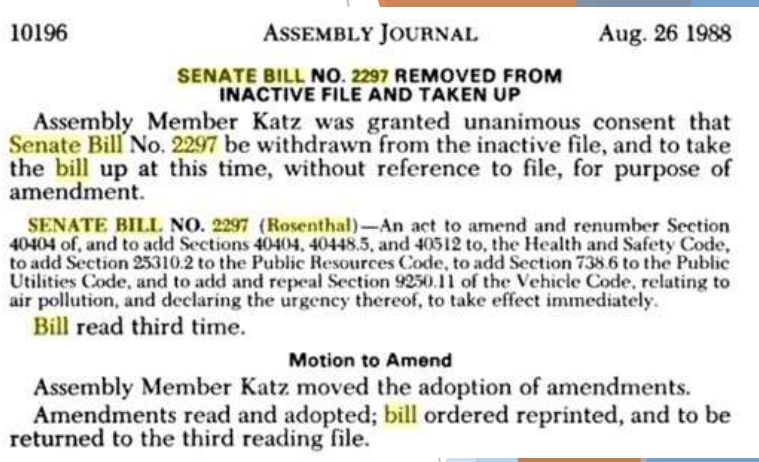
March 2018

CLEAN FUELS PROGRAM 2017 Annual Report and 2018 Plan Update

Background

- 2018 - 30th year since SB 2297 (Rosenthal) created the Clean Fuels Program
  - Initially "to establish a five-year program to increase the use of clean fuels"
  - Sunset clause removed, subsequently
- 2017 Annual Report and 2018 Plan Update
  - Annual Report on Clean Fuels Program (HSC 40448.5.1)
  - Technology Advancement Plan (Update) (HSC 40448.5)
  - Draft 2018 Plan Update submitted to Technology Committee October 20, 2017
  - Annual public hearing to approve Annual Report and adopt final Plan Update
  - Submit to Legislature by March 31 every year

A bit of history…



10196 ASSEMBLY JOURNAL Aug. 26 1988

SENATE BILL NO. 2297 REMOVED FROM INACTIVE FILE AND TAKEN UP

Assembly Member Katz was granted unanimous consent that Senate Bill No. 2297 be withdrawn from the inactive file, and to take the bill up at this time, without reference to file, for purpose of amendment.

SENATE BILL NO. 2297 (Rosenthal)—An act to amend and renumber Section 40404 of, and to add Sections 40404, 40448.5, and 40512 to, the Health and Safety Code, to add Section 25310.2 to the Public Resources Code, to add Section 738.6 to the Public Utilities Code, and to add and repeal Section 9250.11 of the Vehicle Code, relating to air pollution, and declaring the urgency thereof, to take effect immediately.

Bill read third time.

Motion to Amend

Assembly Member Katz moved the adoption of amendments.

Amendments read and adopted; bill ordered reprinted, and to be returned to the third reading file.

Input and Feedback

- Advisory group meetings
  - September 2017 and January 2018
  - Technology Advancement Advisory Group
  - Clean Fuels Advisory Group
  - Invited technical experts
- Meetings with agencies, industry groups, technology providers and other stakeholders
- The Emerging Technologies Summit (April 2017)
- ACT Expo (May 2017)
- The Asilomar Conference on Transportation & Energy Policy (August 2017)
- Technology roundtables and tours in Europe (October 2017)

Clean Fuels Program-Core Technologies

- Hydrogen/Fuel Cell Technologies and Infrastructure
- Engine Systems/Technologies (ultra-low emission NG HDVs)
- Electric/Hybrid Technologies and Infrastructure
- Fueling Infrastructure and Deployment (NG/RNG)
- Fuels/Emissions Studies
- Stationary Clean Fuel Technologies
- Emission Control Technologies
- Health Impacts Studies
- Technology Assessment/Transfer and Outreach

2017 – Key Funding Partners

Total = $20.5M

Targeted Air Shed - DERA - CATI

THE PORT OF LOS ANGELES

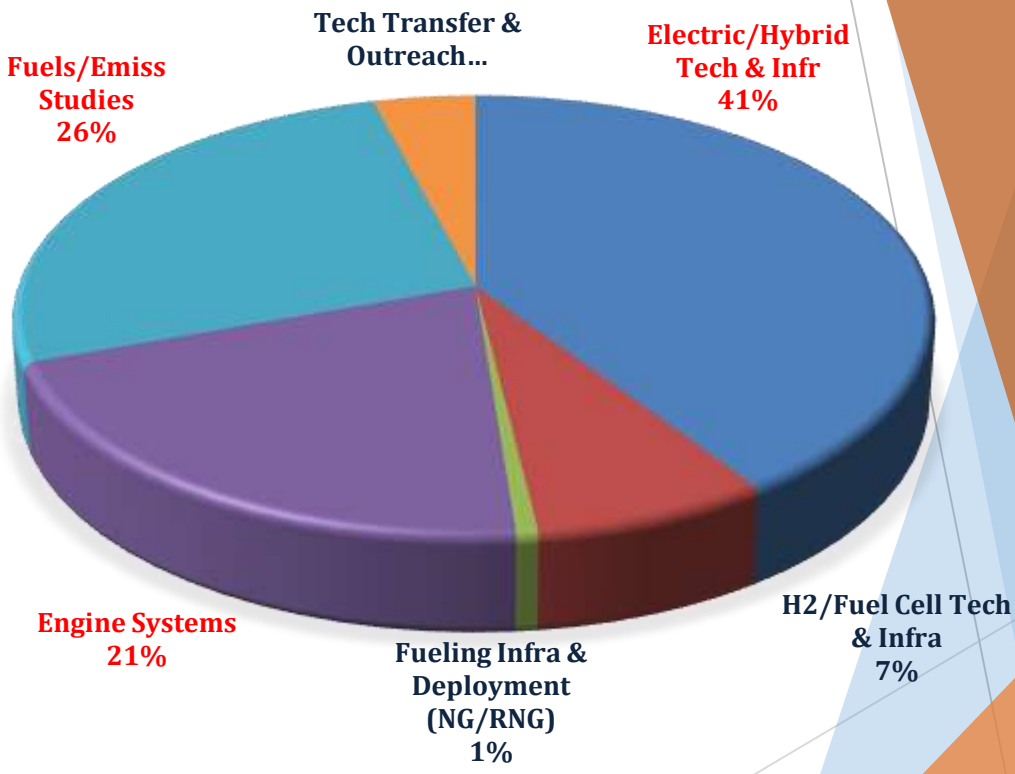
Port of LONG BEACH
The Green Port

Southern California Gas Company

CY 2017 Accomplishments

- 67 – Contracts executed
  - $17.9M from Clean Fuels Fund
  - $118.7M – total project costs
  - 1:6+ leveraging (not typical*)
- 8 - Revenue agreements executed - $14.3M
- 43 - Completed projects
  - 19 research, development, demonstration and deployment projects
  - 24 technology assessment/transfer and outreach projects

Distribution of Executed Contracts



*Typical cost leveraging is $3-$4 per every Clean Fuels $1

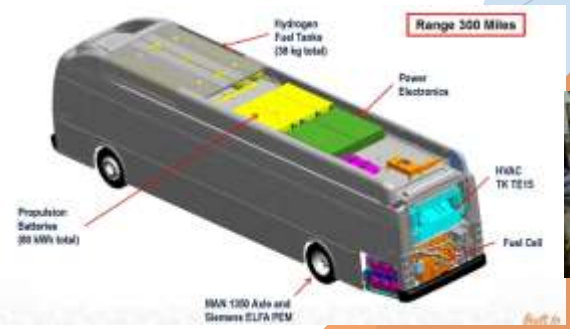
2017 Key Contracts Executed

- GGRF Zero Emission Drayage Truck Demonstration Project
  - BYD
  - Kenworth
  - Peterbilt
  - Volvo
- Class 5-7 PHEV for work applications
- In-use emissions studies, developing cargo loading and movement strategies
- Zero emission fuel cell electric buses



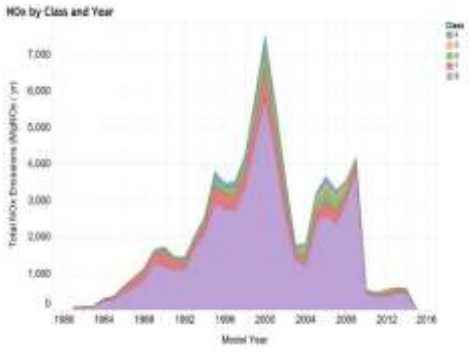


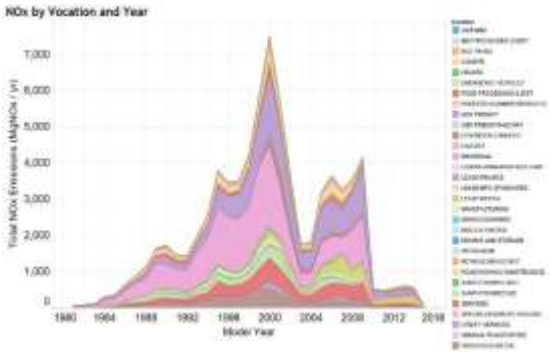




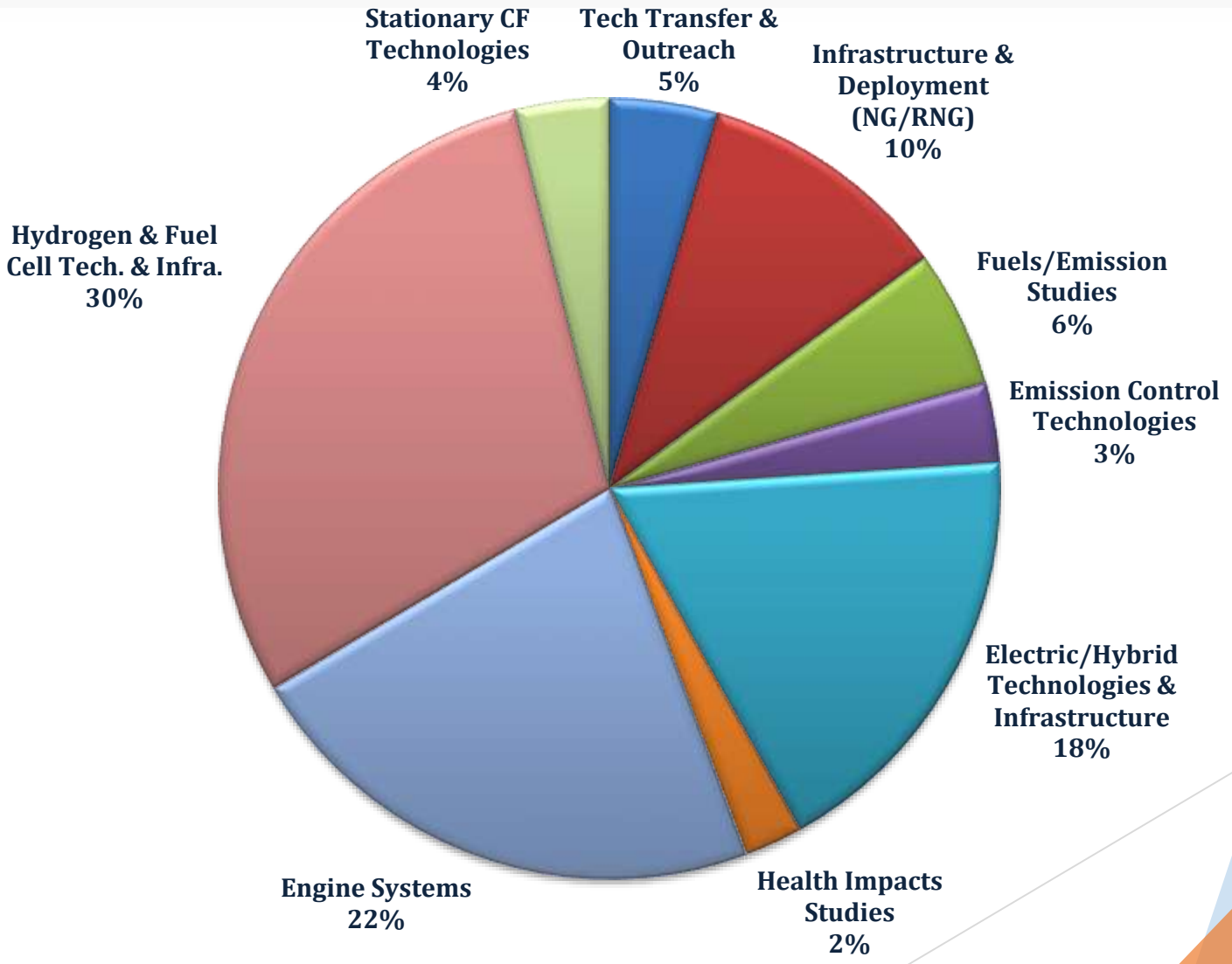
2017 Key Projects Completed

- Engine systems
  - Ultra-low emission 12L natural gas engines
- Electric/hybrid technologies
  - Class 8 zero emission electric trucks
  - UPS zero emission medium-duty delivery trucks
- Fuels/emissions studies
  - Fleet DNA study to provide vehicle vocational analysis





Draft 2018 Plan Update



$16.7M

Proposed 2018 Plan Distribution

	2017 Plan	Draft 2018 Plan
H2/Fuel Cells Technologies & Infra.	33%	30%
Engine Systems	18%	22%
Electric/Hybrids Technologies & Infra.	18%	18%
Fueling Infra. & Deployment (NG/RNG)	11%	10%
Fuels & Emissions Studies	6%	6%
Emissions Control Technologies	3%	3%
Health Impacts Studies	3%	2%
Stationary Clean Fuel Technologies	4%	4%
Tech Assessment/Transfer & Outreach	4%	5%
	100%	100%

Development Schedule

➢ Technology Committee	October 20, 2017 (Draft 2018 Plan Update)
➢ Advisory Group Review	September 7, 2017 January 31, 2018
➢ Technology Committee	February 16, 2018
➢ Board Approval	March 2, 2018
➢ Due to State Legislature	March 31, 2018