Electric Vehicle Supply Equipment (EVSE) Certification

EVSE Certification

Electric vehicle charge stations must comply with the US National Electric Code (NEC)

- AHJs – “Authority Having Jurisdiction” (often electrical code inspectors) have final say in the acceptance of equipment and electrical installations
- The NEC tells the AHJ that one way of knowing a piece of equipment is ok is to look for the listing mark of an approved lab
- In the case of EV charging systems, Article 625 indicates that all electrical materials, devices, fittings and associated equipment shall be listed or labeled
  - 625.1 Scope – The provisions of this article cover the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive or inductive means, and the installation of equipment and devices related to electric vehicle charging

EVSE Certification

If you are selling and/or installing EVSE

- You have a responsibility to demonstrate compliance to the NEC
- Product testing and certification – "Listed" – by an independent body recognized for their competency in electrical or mechanical safety is the most commonly accepted method
- Certification assists with market entry, and communicates compliance to AHJ's, buyers and consumers

EVSE Certification

Independent bodies recognized for their competency in electrical testing and certification are generally known in the US as Nationally Recognized Testing Laboratories (NRTL)

Lab, Listed, Mark, Label – Approved by who???

- OSHA (U.S. Department of Labor: Occupational Safety & Health Administration) oversees safety regulations, which are US law and contain requirements for "approval" (i.e., testing and certification) of certain products by a NRTL
- Requirements are found in Title 29 of the Code of Federal Regulations (29 CFR), and the provisions for NRTL certification are generally in Part 1910 (29 CFR Part 1910)

EVSE Certification

An NRTL is an organization that OSHA has "recognized"

- A NRTL is authorized to provide an independent evaluation, testing and certification of electrically operated or gas- and oil-fired products based on standards developed by U.S.-consensus standards organizations such as the American National Standards Institute (ANSI) and Underwriters Laboratories (UL)
- “Recognition” includes demonstrating to OSHA the capability, control programs, independence, reporting and complaint handling procedures to test and certify specific types of products for workplace safety

EVSE Certification

What process does OSHA follow in recognizing an NRTL?

- Appendix A to 29 CFR 1910.7
- OSHA performs an in-depth on-site review of the organization and facilities
- OSHA publishes a notice of finding in the Federal Register for 30 day public comment period
- OSHA publishes a second notice of its final decision
- The recognition remains in effect for a five-year period
- For foreign-based organizations, the Department of Commerce must consider "reciprocity" of the foreign government

EVSE Certification

How does OSHA enforce the requirements for NRTL approval?

- Typically audit each NRTL annually to verify that it sustains the quality of its operation and continues to meet program requirements
- OSHA compliance officers could review specific products during workplace inspections, verifying the certification mark of an NRTL

EVSE Certification

What standards can an NRTL use in certifying products?

- An NRTL must use "appropriate" standards in certifying products for workplace safety (see Test Standard Approval Criteria in the NRTL Program Directive)
- International Electro-technical Commission (IEC), Underwriters Laboratories (UL), the National Fire Protection Association (NFPA), IEEE, and ASTM International, etc.

EVSE Certification

Does OSHA accept the "CE Mark", or equipment certified by foreign testing organizations?

- The CE mark is a generic mark used in the European Union (EU) to indicate that a manufacturer has declared that the product meets EU safety requirements
- CE is unrelated to the requirements in the US
- In the US, the product must have the specific mark of a recognized NRTL
- However, data used to attain NRTL certification, may be applicable to declaration of compliance for CE marking

EVSE Certification

Can an NRTL use other parties to do part of the work necessary in testing and certifying products?

- OSHA permits this, provided the NRTL has met certain criteria
- With appropriate controls in place, a NRTL may accept testing, evaluation data or certain contract services, from outside parties

EVSE Certification

Do NRTLs recognize each other's product testing, certification, or approvals?

- OSHA has no authority to require such acceptance
- This is solely a business decision of each NRTL

EVSE Certification

Does OSHA subsidize or indemnify NRTLs?

- NRTLs are private organizations or companies
- They are not financially or otherwise supported, subsidized, or indemnified by the Government in their capacity as an NRTL
- These organizations maintain the risks and liabilities for their actions

EVSE Certification

Are OSHA recognized NRTLs equal in ability?

- Given that each NRTL has met the same requirements for recognition, OSHA considers NRTLs, recognized for the same product safety test standard, to be equivalent
- **However, each NRTL is an independent business and will operate as such. They may provide different levels of service, costs, ongoing support, etc.**

EVSE Certification

How do I know whether an NRTL has certified a product?

- Each NRTL uses its own unique, registered certification mark(s) to designate conformance
- Each NRTL must register its certification mark(s) w/the US Patent & Trademark Office
- The manufacturer physically places the mark on the products
- An NRTL must ensure that its mark is applied to each unit, or if not feasible, to the smallest package containing each unit

EVSE Certification

What does a safety mark tell me?

- Safety marks such as ETL, UL, and CSA signify that the product has been tested to, and found to comply with, national safety standards by a qualified, independent testing laboratory
- The presence of a safety mark also means the product is ‘listed’ in the NRTL’s “directory” – public record.
- And, is part of an on-going follow-up program that ensures the products continued comply with the applicable standards

EVSE Certification

What's the difference between the UL, CSA, and ETL Marks?

- All of these Marks demonstrate that the product that bears it has met the minimum requirements of widely accepted product safety standards as determined through the independent testing
- The only real differences between the Marks are in the services of the testing laboratory behind them

EVSE Certification

Aren't manufacturers required to use UL for their compliance testing? Isn't this mandated by the standards themselves?

- The simple answer to both questions is "no"
- In fact, this misconception has misled many manufacturers to believe that they don't have a choice in their third-party testing partner
- To satisfy the prerequisite of having your products tested by an independent organization, the true legal requirement is that the laboratory which performs the testing be a Nationally Recognized Testing Laboratory (NRTL) recognized by OSHA

EVSE Certification

Where can I view the current list of NRTLs?

- http://www.osha.gov/dts/otpca/nrtl/index.html

How do I choose which NRTL to use?

- When choosing a testing and certification partner, make a list of your key purchasing drivers and use this as your guide
- Compare what you are looking for with the services that each NRTL provides
- Like any other product or service, competition is best for the “purchaser” and the marketplace

EVSE Certification

Are EVSE even covered under the jurisdiction of OSHA and the NRTL program?

- The NRTL program has a defined list of applicable standards
- Depending on design, in the US EVSE is subject to evaluation against:
  - UL 2231-1, UL2231-2, UL2251, Subject UL2594 & UL2202
  - Today, only UL2202 is on OSHA's list
  - However, it's become generally accepted practice within many markets and jurisdictions to utilize NRTL status as indicator of competency
  - And it is very direct way to demonstrate compliance with the NEC

EVSE - Testing & Certification Standards

Intertek Applies EV UL Safety Standards

Hybrid Battery

UL Subject 2580

Battery Charger (on/off board)

UL 2202

Charging Inlet

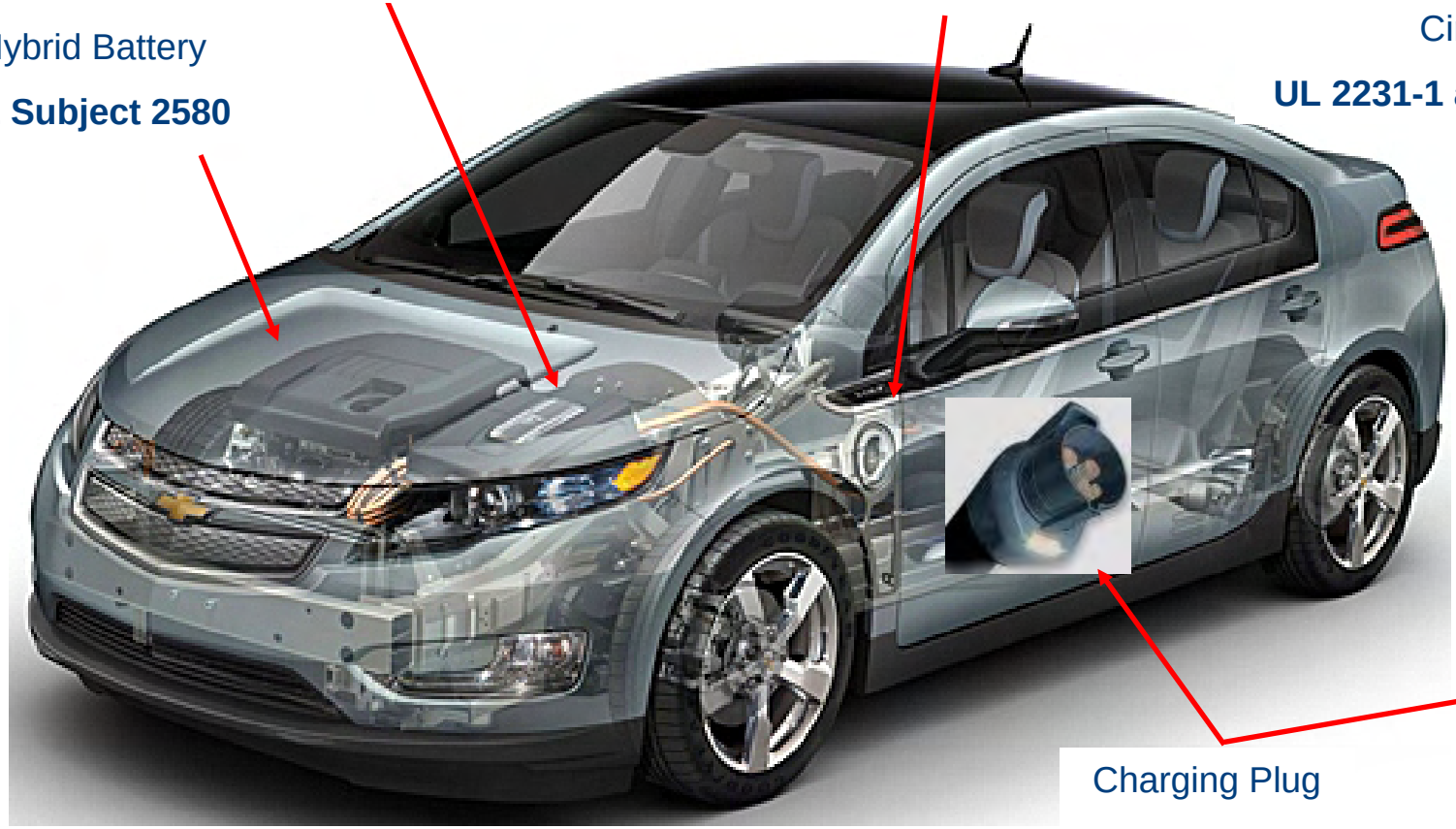
UL 2251

Charging Station (EVSE)

UL Subject 2594

Personnel Protection Circuitry

UL 2231-1 and UL 2231-2



Charging Plug

UL 2251

Vehicle pictured is used for illustrative purposes only - no further claims are made or intended

Intertek Applies EV International (IEC) Standards

On Board Battery Charger

IEC 61851

Charging Inlet

IEC 62196

Charging Station (EVSE)

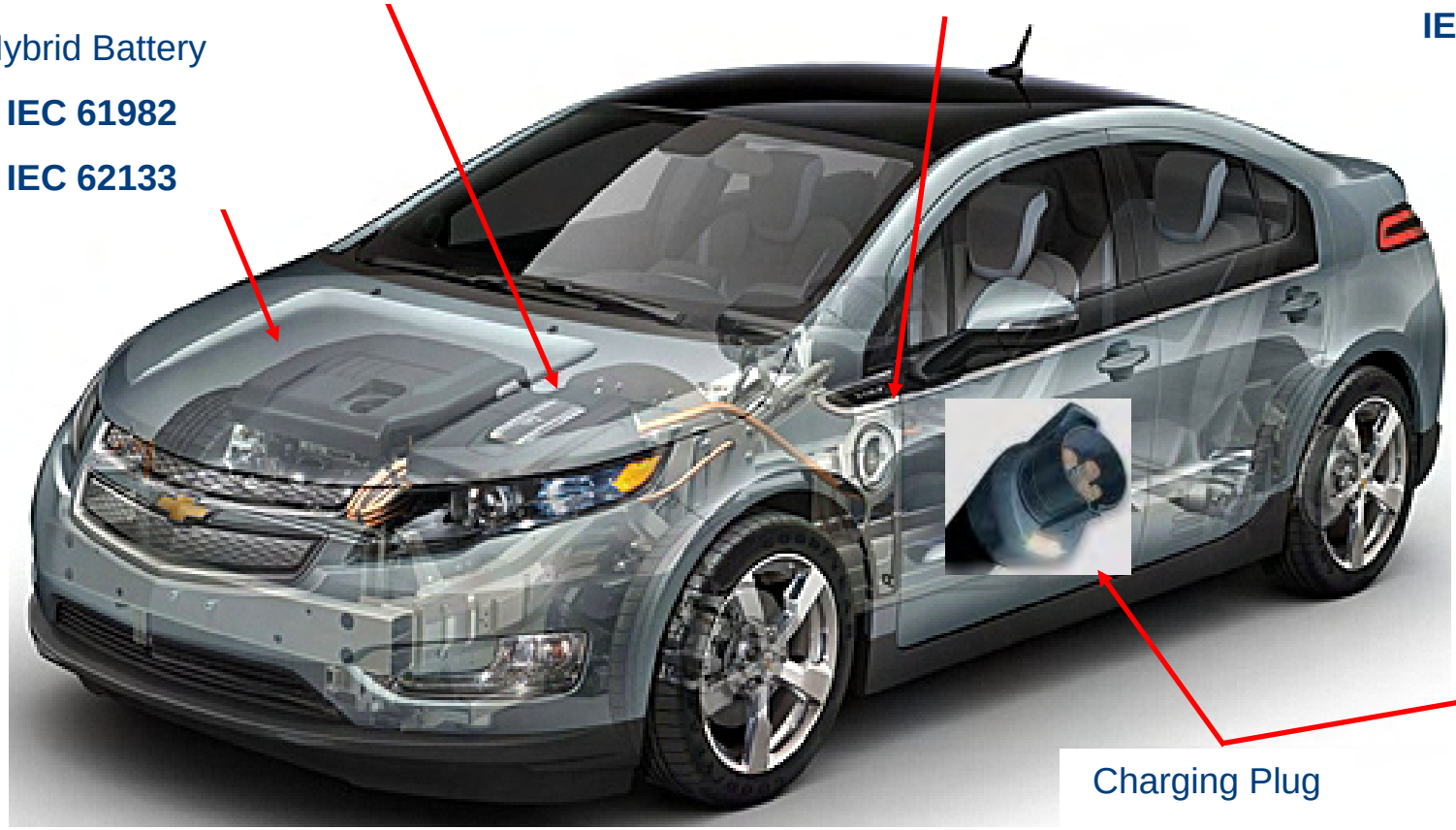
IEC 61851

IEC 60950

Hybrid Battery

IEC 61982

IEC 62133



Charging Plug

IEC 62196

Vehicle pictured is used for illustrative purposes only - no further claims are made or intended

Intertek Applies EV SAE Standards

Hybrid Battery Safety

SAE J2929

Abuse

SAE J2464

On Board Battery Charger

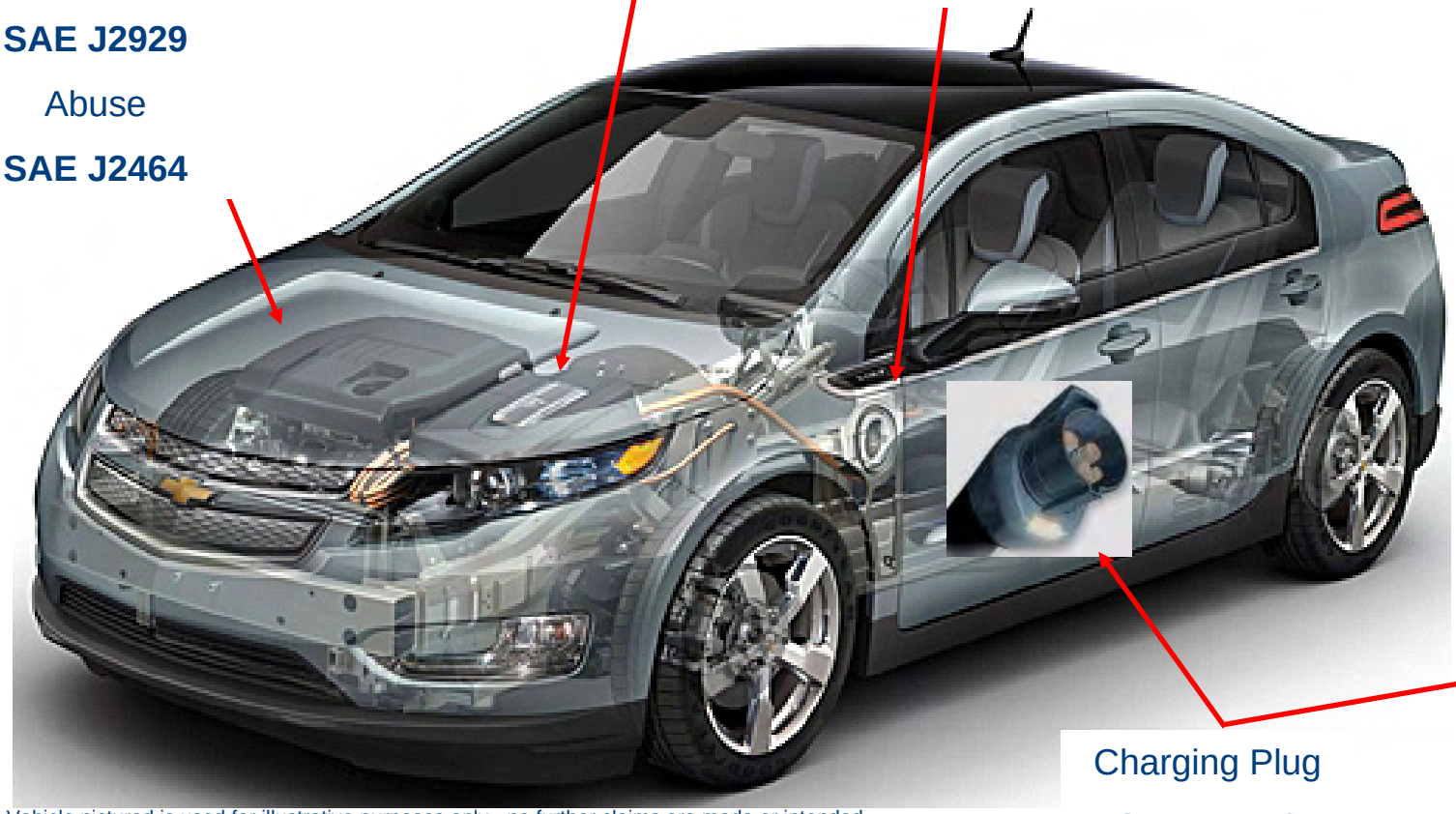
SAE J2894 (Power Quality)

Charging Inlet

SAE J1772

Charging Station (EVSE)

SAE J2293



Charging Plug

SAE J1772

Vehicle pictured is used for illustrative purposes only - no further claims are made or intended

Charge Station Certification

UL Subject 2594

OUTLINE OF INVESTIGATION FOR Electric Vehicle Supply Equipment Issue Number: 1
November 5, 2009

This outline covers electric vehicle (EV) supply equipment, rated a maximum of 250 V ac, with a frequency of 60 Hz, and intended to provide power to an electric vehicle with an on-board charging unit.

Wall Mount Charge Station for homeowners – typically mounted in the homeowners garage and connected to 240VAC 60Hz source for high amperage charging.

Travel Cordset Charge Station for homeowners, device is typically carried in the vehicle for charging while on the road. Typically connects to 120VAC 60Hz source.

Lower amperage charging.

Municipal Charge Station – can be provided with both 120VAC 60Hz and 240VAC 60 Hz sources. Can be mounted anywhere, parking lots, hotels etc.

May be provided with a variety of options for things such as credit card readers, I/O ports for recording data etc.

Charge Stations – Personal Protection System Certification

Devices covered by UL 2231-1 and UL 2231-2 are typically control circuits that are not complete products but are circuit boards to be fitted into a charging station

UL 2231-1

Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements First Edition

These requirements cover devices and systems intended for use in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, Article 625, to reduce the risk of electric shock to the user from accessible parts, in grounded or isolated circuits for charging electric vehicles. These circuits are external to or on-board the vehicle.

UL 2231-2

UL Standard for Safety for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems, First Edition

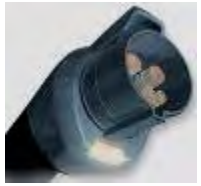
This standard is intended to be read together with the Standard for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements, UL 2231-1. The requirements of UL 2231-1 apply unless modified by this standard. This Part contains the construction and performance requirements that are applied to a device that is intended to become an integral part of an overall device or charging system.

EV Receptacle Certification

UL 2251

UL Standard for Safety for Plugs, Receptacles and Couplers for Electric Vehicles, First Edition

These requirements cover plugs, receptacles, vehicle inlets, and connectors, rated up to 800 amperes and up to 600 volts ac or dc, intended for conductive connection systems, for use with electric vehicles in accordance with National Electrical Code (NEC), ANSI/NFPA-70 for either indoor or outdoor nonhazardous locations.



Vehicle Coupler – Standard configuration coupler for providing power to the on-board charger. Specified by SAE 1772

Vehicle Inlet – Standard power inlet for coupling to Standard SAE 1772 Coupler

EV Level 3 Charger Certification

UL 2202

UL Standard for Safety for Electric Vehicle (EV) Charging System Equipment, Second Edition

Supplied by circuit of 600Volt or Less

For recharging batteries in over the road EV's

On-board or Off-board the vehicle.

"LEVEL 3" Chargers fall under this standard

About Intertek

2009: FTSE 100

2002: Intertek, becomes a public company traded on London Stock Exchange

1996: Intertek Testing Services purchases Inchcape Testing

1988: Inchcape acquires ETL

1942: Edison required to divest company--ETL registered as a separate company

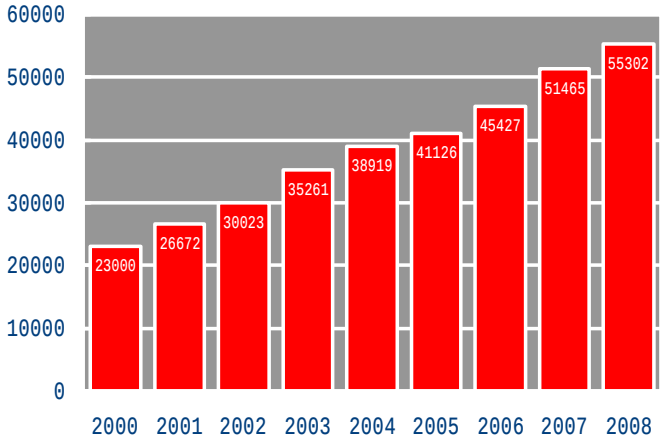
1904: Edison renames his Lamp Testing Bureau “Electrical Testing Laboratories”

1896: Edison separates Lamp Testing Bureau from manufacturing

Thomas Edison

About Intertek

- Billions of products around the globe feature Intertek certification marks
- 62,000+ Listed product types across North America, from more than 10,000 clients
- We conduct more than 2,000,000 annual tests, inspections, certifications
- Testing to more than 1,000 ANSI, ASTM, CSA, NFPA, IEC, SAE, UL and other standards around the world
- **Fully Accredited Services – OSHA/NRTL**
- Intertek Certified
  - Chevy Volt “Voltec” EV Charging Technologies
  - Eaton’s “Pow-R-Station” EV Charging Station



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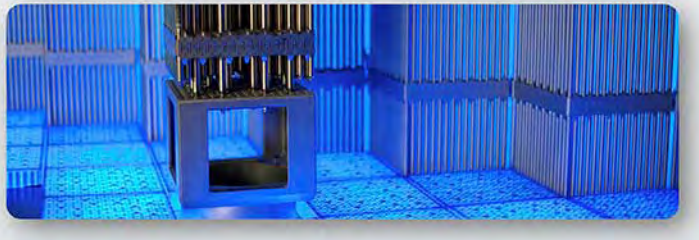


ELECTRIC POWER RESEARCH INSTITUTE

Port, Rail, Truck Electrification (PoRTE) Update

Non-road Electric Transportation

Andra Rogers
Sr. Project Manager

Infrastructure Working Council
March 2, 2011

Non-road results in 2010

- Completed a case study on Electric Refrigerated Container Racks for Ports and Intermodal Facilities
  - ~29 tons of CO2 per year
    (for comparison an average vehicle would be ~5 tons of CO2 per year)
  - 8662 kWh per year, GPA will have 93 racks when completed

22 Diesel powered truck refrigerated units (TRUs), powered by the "rack"

3,000 hours annually	Diesel TRU	Electric TRU
Average Fuel/Electricity Usage	0.735 Gal./Hour	2.8875 kWh/Hour
Price	$1.87/Gal.	$0.107/kWh
Cost to Operate Annually	$4,123	$927

Non-road results in 2010

- PHEV Yard Tractor Demonstrations
  - Port of Long Beach, 4.5 mi/gal, BMS failure, good reception from users
  - Port of Houston, 5.8 mi/gal, replaced pump, and had DC/DC converter failure, good reception from users
  - Port of Savannah, controller governed speed and not sufficient for multiple operations, mpg data not reliable
  - New York Container Terminal, smaller footprint, speed govern said not an issue

Non-road results in 2010

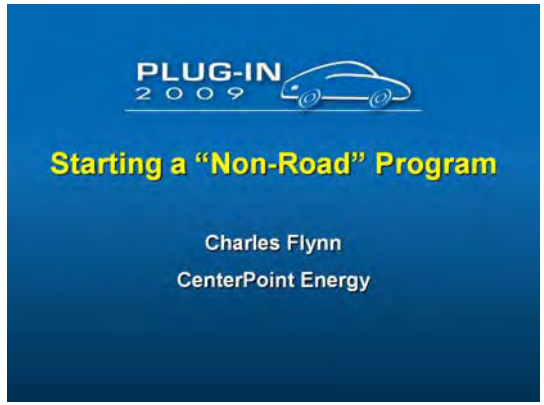
- Completed a white paper on Economic and Environmental Analysis of Fuel Cell Powered Materials Handling Equipment
- Completed a study on Alternative Ground Support Equipment Electrification Analysis
- Completed a study of Mining Electrification: An Investigation of the Use of Electric Equipment in the Mining Industry
- Completed Electric ATV demonstration in CA (Agriculture) and FL (Military)

Non-road membership projects for 2011

- Market Transformation Demonstrations Opportunities:
  - Electric Dredge Data Collection
  - Fast charging forklift demonstration
- Non-Road EV Technology Assessment
  - Mining Equipment Electrification Expansion: eMeter electric equipment to determine usage and benefits of introducing fast charging and efficient alternatives such as conveyer systems
- Fleet Applications for PEVs – Green Fleet Study
  - Review light duty alternatively fueled fleet vehicle options and evaluate EPACT/Green Fleet Compliance

Non-road Electric Transportation Feasibility Assessment and Demonstration

- Foundation/First step of the Non-road Electric Transportation Feasibility Assessment and Demonstration completed in December 2010
  - Define, assess, and quantify the operational and load characteristics of various non-road electric technologies
  - Rank the technologies by sector and technology potential
  - Provide general recommendations on technologies suitable for further analysis



Market Assessment

- Further Program Screening/Market Assessment
  - Purpose – to package attractive technologies into high-level programs for the purposes of estimating penetration, program costs, and economic impacts
  - Validate the ability the technology benefits to support the program costs and calculate B/C ratios
  - Determine a Low to High Net Benefit Range
  - Expect total list of technologies to narrow down to 3-6 programs

Business Case/Program Design

- Convert best High-Level designs into well thought out actionable program recommendations and business case for utility executive management
- Focus on “new, emerging style” market transformation designs
- Address:
  - Technology summary
  - Financials
  - Market description
  - Competition
  - Strategies
  - Market barriers and entry strategies
  - Resource requirements
  - Risk and mitigation strategies

And add: Study on added benefits of Non-road

- Contribution of Achievement of Energy Efficiency and Demand Response Goals
  - Because electricity use increases, under most likely scenarios charging is done during non-peak hours, there are additional benefits that accrue to consumers and society in general
  - This study will consider the extent of these benefits and how they translate into environmental and economic gains to facilitate evaluation non-road transportation investments
- Deliverable will be a white paper that can be shared with your management and your regulators

What's next: Join the supplemental

- Ready? Join the program as a Demonstrator
  - Choose 6 technologies to research for your territory
  - We'll assess your market for the chosen technologies, complete a business case based on your criteria, and develop up to 4 utility programs to be run internally or by a third party
  - Receive the white paper
- Not ready just yet? Join the program at the Participant level
  - Receive models developed within this effort, and enter in your own numbers, based on what you know of your market and your business case criteria
  - Receive the white paper

Contact Information

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Together...Shaping the Future of Electricity

Public information: http://www.epri.com/et

Together…Shaping the Future of Electricity

ELECTRIC POWER RESEARCH INSTITUTE

Control Module Industries

CabAire LLC
& EVSE LLC

Presentation To:
EPRI IWC
March 2, 2011

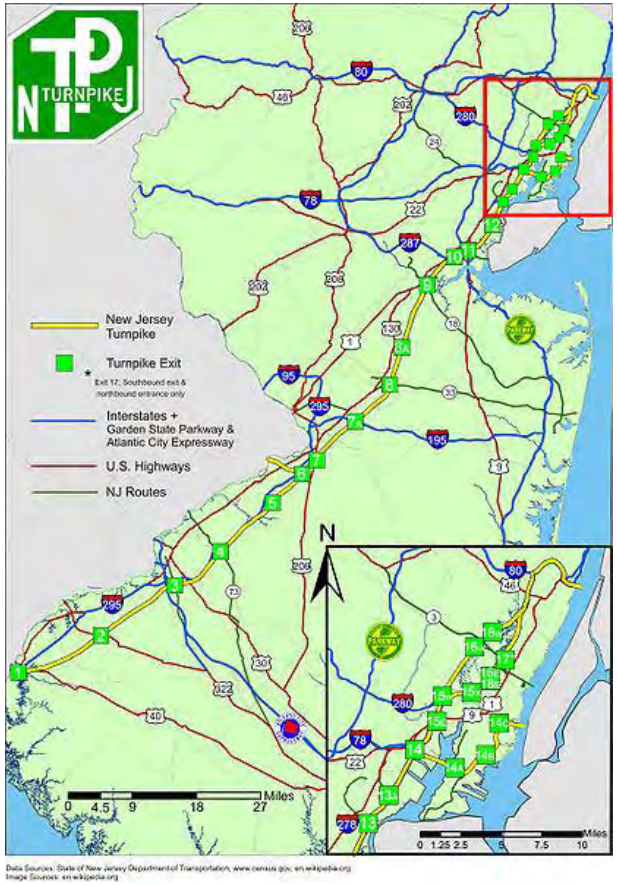
Patents Pending

Smart Charging Solutions for Electric Vehicles

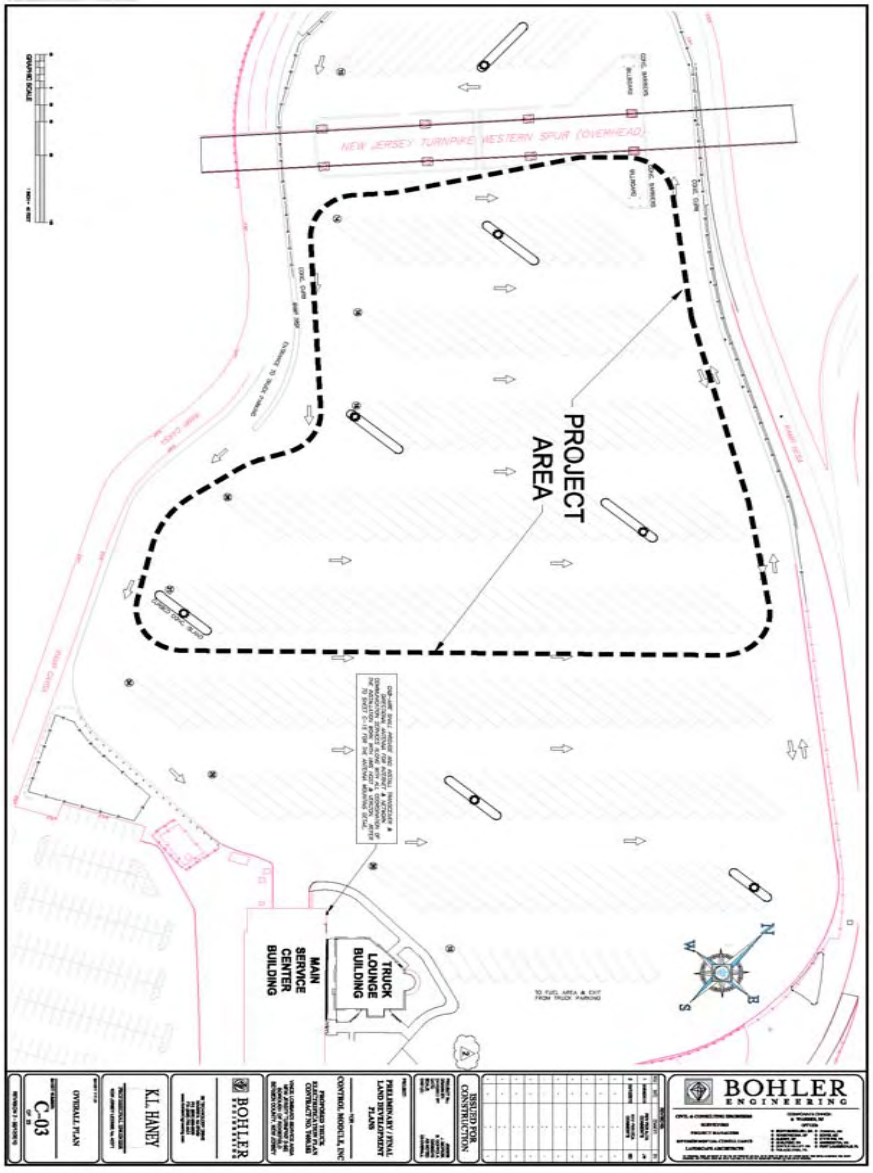
Control Module Industries
Founded in 1969
EVSE LLC

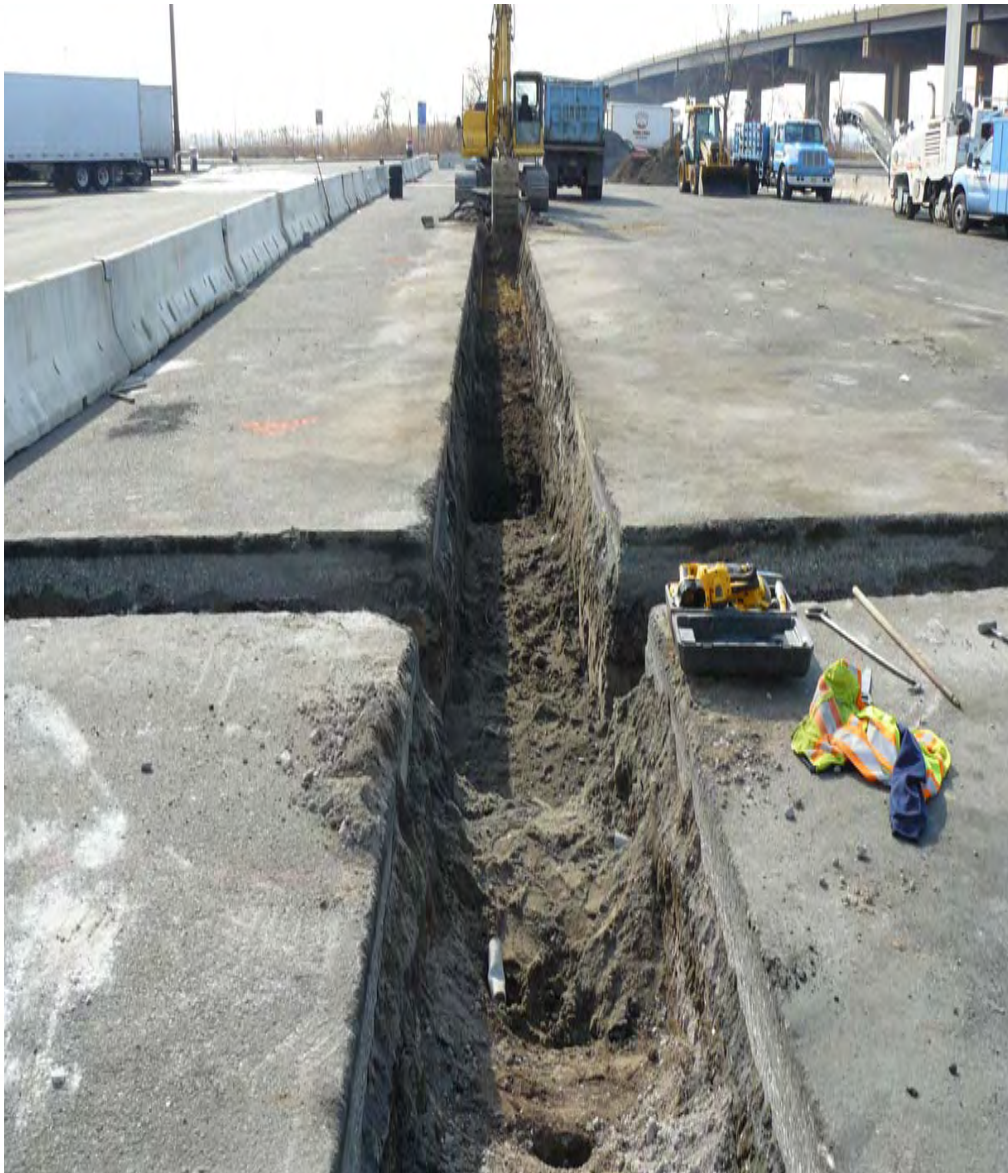
New Jersey Turnpike
Vince Lombardi Service Area

- Vince Lombardi Plaza
- I-95 Corridor
- Four major freight lanes
- Vince Lombardi Plaza
  - 250 truck spaces
  - 86 dedicated to TSE
- 700,000,000 vehicles travel the NJT annually

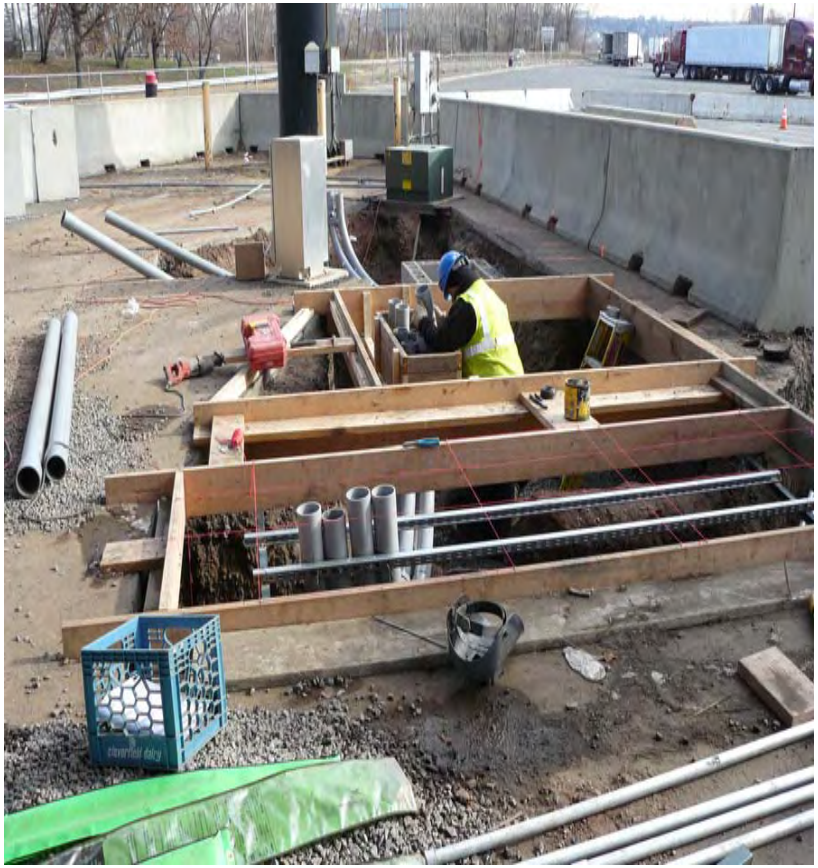


TSE Construction Project Area





Power & Distribution
Conduits, Footings, Main Switch, Com Cabinet



Phase 1 Complete
Opening May

CabAire Dual Service Towers

- 43 Dual towers serve 86 spaces
- Each tower serves 2 trucks
- HVAC with UV treated air
- Shore power connections
- Internet and TV connections

EVSE LLC

Power Share &

Cable Management

Power Share Module

Add an EVSE without the Costs of Electrical Service Upgrade

- Many homes will require electrical service upgrades for Level 2 EVSE causing delays for consumers & car dealers
- Upgrade service costs: $2,000 to $4,000
- Plus permits/inspection require 6 to 8 weeks
- Power Share eliminates these costs and time delays by using an existing 240VAC/40A appliance breaker
- When EVSE is in use and Power Share senses power request from electric appliance, the Power Share reduces the power to EVSE
- When appliance is shut off, full power returns automatically to the EVSE
- Power Share reduces the cost of electric vehicle ownership & streamlines EV adoption

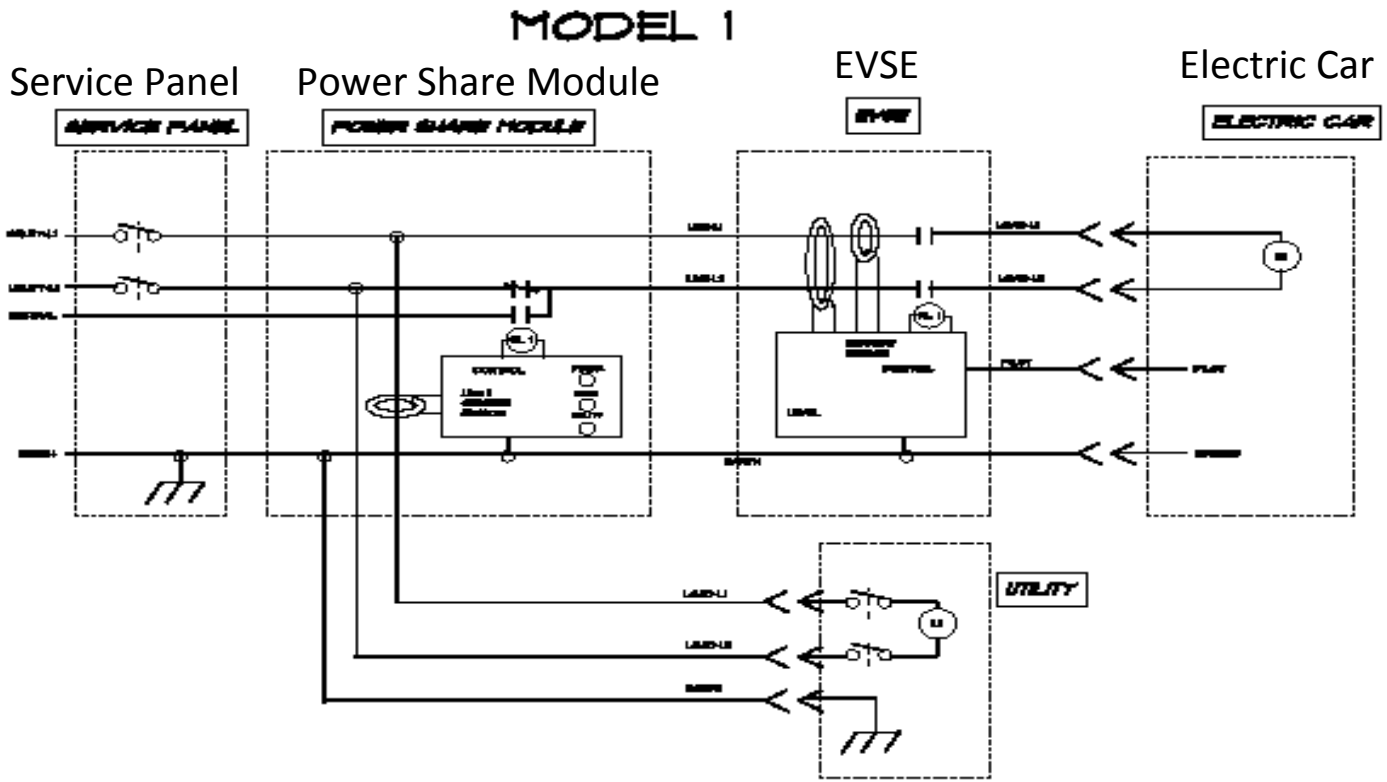
Power Share Modules

- Power Share Module 1
  - Residential Utility Monitor 40A EVSE - Wireless
  - Works with EVSE LLC chargers only
- Power Share Module 2
  - Residential Utility Monitor 40A/70A EVSE – Level & Contact Control
  - Works with other EVSE manufacturers
- Power Share Module 3
  - Multi-Dwelling Service Monitor 40A/70A EVSE/Level and Contact Control

Residential Power Share Model 1

- 220V power is applied to both the EVSE and the appliances (e.g. stove or dryer) from shared breaker
- Current to appliances is measured
- When appliance current exceeds set level, a contact closure switches EVSE to standby mode
- When appliance current is below set level, the EVSE is returned to charge mode
- Works with Control Module's EVSE level control

Inside Power Share Module 1

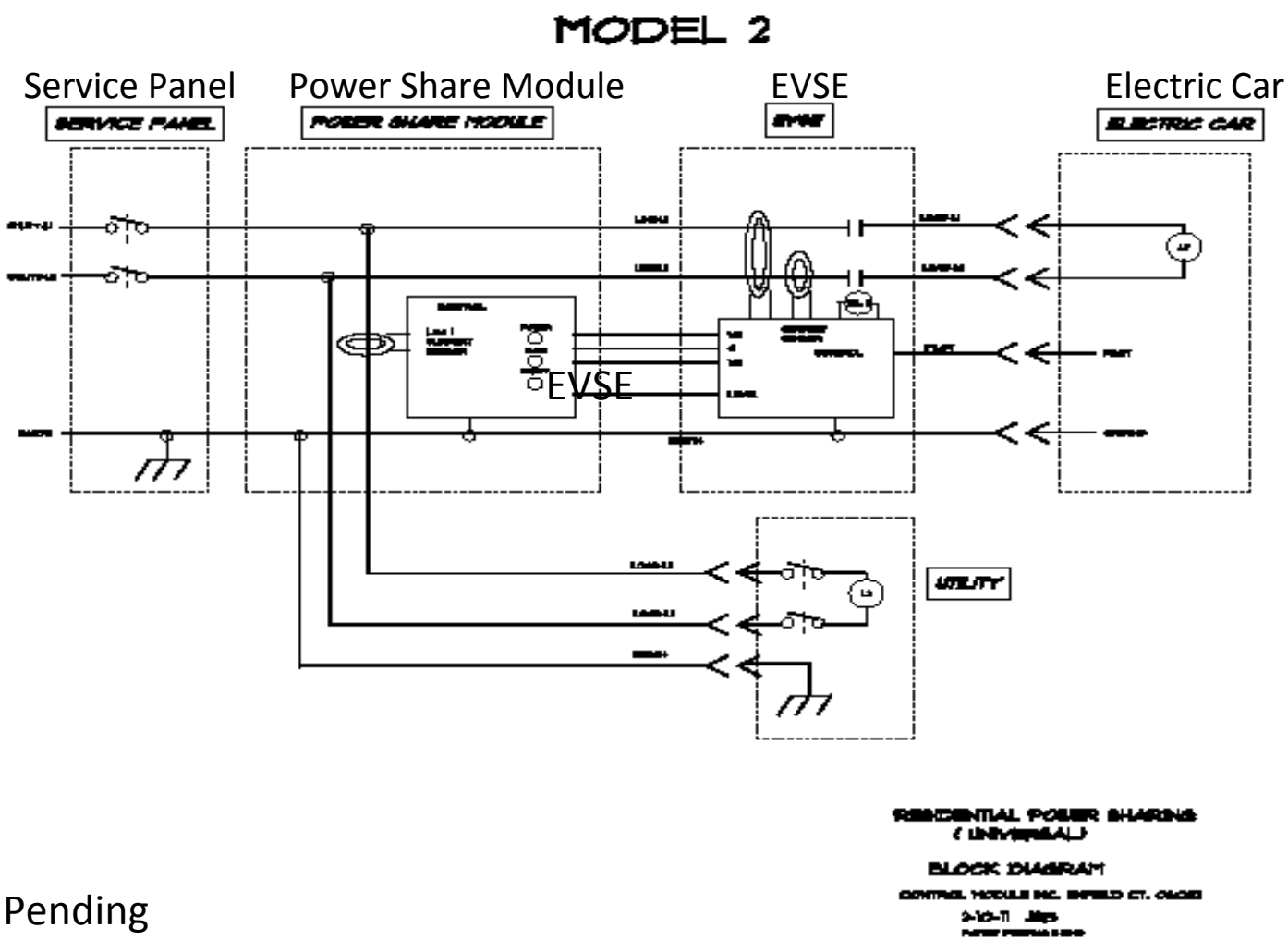


Patent Pending

Power Share – Model 2

- 220V power is applied to both EVSE and appliance (stove or dryer) from shared breaker
- Current to appliance is measured
- When appliance current exceeds set level, a contact closure switches EVSE to standby mode
- When appliance current is below set level, the EVSE is returned to charge mode
- Works with other EVSE equipped with standby contact control

Inside Power Share Model 2

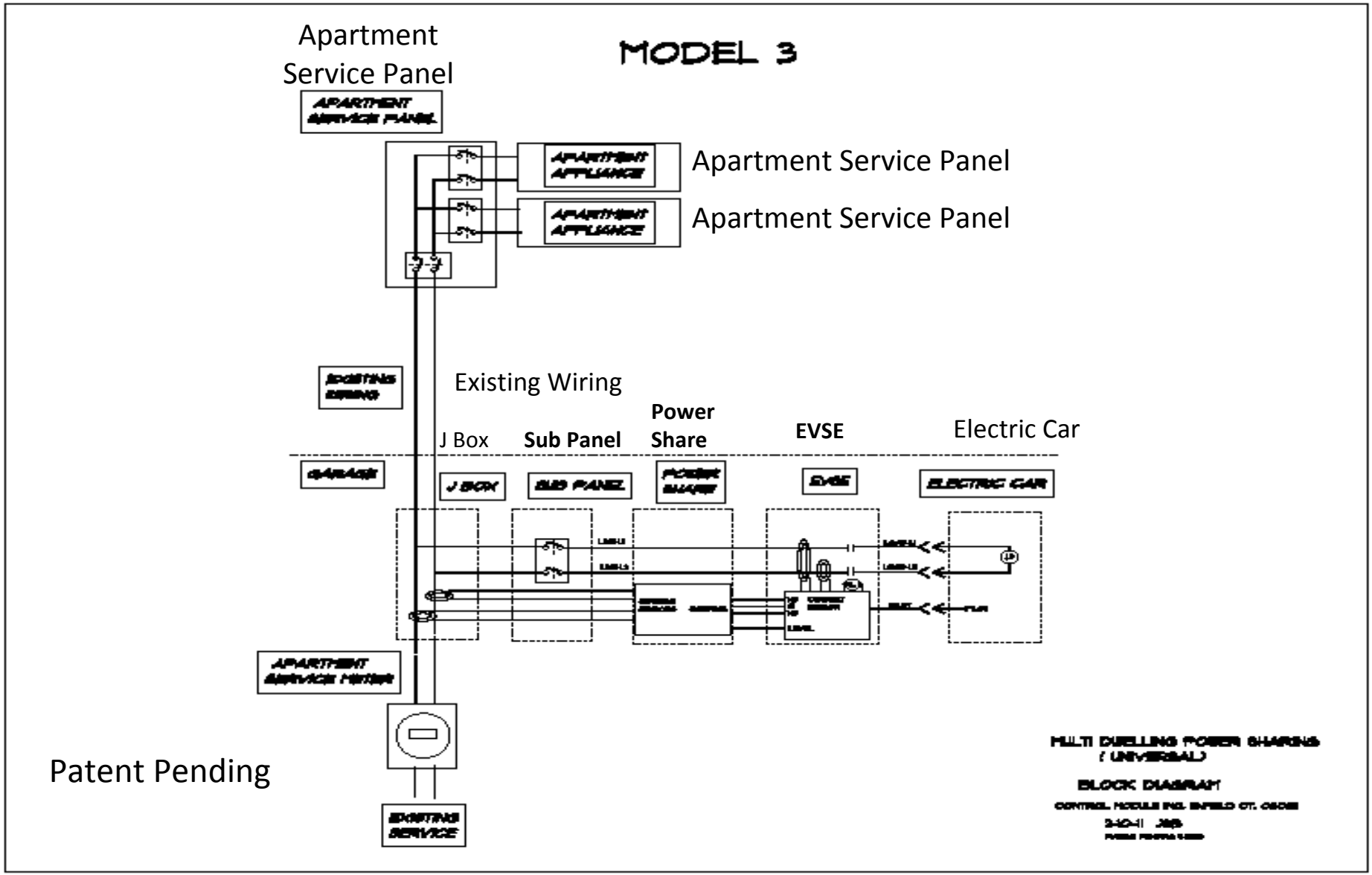


Patent Pending

Power Share Model 3 - MDUs

- 220V line power is tapped off service entry after meter
- New local breaker for EVSE installed
- Power share measures current to apartment and EVSE
- When line current exceeds preset level a contact closure switches EVSE to standby mode
- When line current is reduced below set level, the EVSE is returned to charge mode
- Works with all EVSE's equipped with standby contact control
- Works with Control Module's EVSE level control

Inside Power Share Model 3

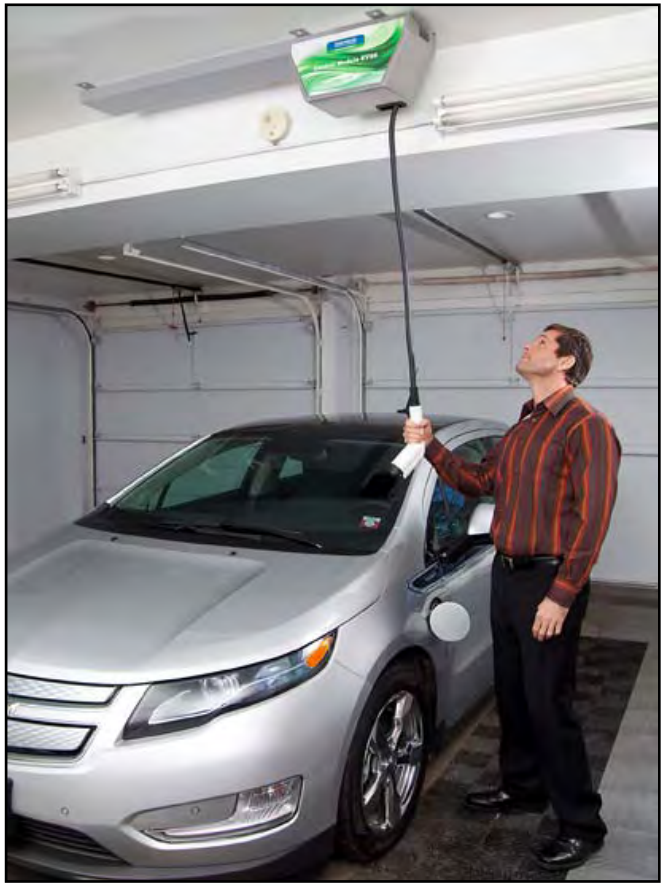


Patent Pending

EVSE & Cable Management Equipment

- Basic EVSE are the same
  - Must meet NEC 625 code
  - Must meet J1772 requirements
- Easy to protect the EVSE unit
- Residential EVSE cables are owned by the homeowner therefore the cables are protected
- Public EVSE cables are hard to protect and subject to:
  - Misuse
  - Weather
  - Vandals
  - Theft

Garage Overhead EVSE With Power Share



Designed for MDU's & Residences

- Uses the Control Module cable management system
- Uses Power Share
- Mounts on ceiling or walls
- Fits neatly between lanes
- Cables store high above customers heads
- Lowers to ADA compliant level when activated
- All EVSE functions and safety protection
- Interfaces with existing payment methods
- Supports Readers:

- Magnetic	- Proximity	- Key Fobs
- Barcode	- RFDI	- Blue Tooth

Marquee EVSE
Designed for Parking Lots

- Uses Control Module Cable Management System
- Mounts curb side
- Fits neatly between lanes
- Available in single, dual or quad versions
- Cable stores high in protective enclosure
- Tamperproof
- Lowers to ADA compliant level when activated
- Interfaces with central payment kiosk
- Attractive space age look

Industrial EVSE
Designed for Fleets & Docks

- Level 2
- 208-220VAC
  - 20-74 Amps
  - J 1772 Compatible
- Detachable Cable
  - Cable travels with vehicle
  - Interlocked switch
  - Lockable cable & switch
- Safety
  - Over current
  - Ground fault protection
  - Self test
  - Re-closure
  - Brown out protection
- Rugged pedestal or wall mount
- Weather proof NEMA 4

Control Module Industries

- Founded in 1969 in Enfield, CT
- Design-Build Electronic/Electromechanical Systems
- 44,000 sq. ft. Engineering & Manufacturing for Fortune 500
- Awarded 100+ US & Foreign Patents
- CabAire LLC – Truck Stop Electrification
- EVSE LLC – Electric Vehicle Supply Equipment

Patents Pending

Summary

- CMI EVSE LLC – A Connecticut Company
- 40+ Years in business
- Profitable, No Debt
- EVSE: One Form Does Not Fit All Locations
- Commercial, Fleets, Residential Have Their Own Needs
- CMI EVSE LLC – Smart Charging Solutions for Electric Vehicles

Chelsea Produce Market

TRU Electrification Project Update

Statistics

- 2nd largest produce market in the country
- 37,000 “refeers” a year enter
- 2,000 – 3,000 trucks a day
- 250 – 500 trucks idling at any one time
- Cold storage trailers idle 24/day, 365/year
  - “RED FUEL” – high sulfur content diesel
- Thousands of tons of hazardous pollutants emitted yearly

Chelsea Health Statistics and Air Quality

- Highest in MA: respiratory illnesses (child-Sr.), strokes, cardiovascular disease
- Highest category for expected lifetime cancer cases from diesel pollution-CATF
- Diesel exhaust level exceeds U.S. average by 5 times-EPA
- Non-attainment area for ozone pollution

The Project's Environmental Benefits

- Repower 79 stationary trailers with electric engines
- Old diesel units replaced with Carrier Vector 5100 all electric TRU with 460V power supply
- Upgrade truck dock electrification system
- Emissions reductions per year
  - 398,389 lbs of Nitrogen Oxides
  - 61,408 lbs of Particulate Matter
  - 215,728 lbs of Hydrocarbons
  - 484,428 gallons of Diesel Fuel eliminated

Contact

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Perspectives on Battery Electric Buses for the EPRI Infrastructure Working Group

Fred Silver
Vice President
3/2/11
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Federal Transit Administration Electric Drive Strategic Plan 2009

FTA's 20-year vision for electric-drive in transit is:

The commercial availability of zero and near-zero emissions, high-efficiency, affordable transit vehicles to transit agencies across the country by 2030 from domestic suppliers

Table 1.3. Transit bus annual emissions, fuel consumption, and cost projections for 2030

Bus Type	Buses	Fuel Consumed (thousand gal diesel equiv)	NOx (tons)	CO_2 (thousand tons)	Fuel Cost ($ millions)
Hybrids	41,000	242,300	1,100	2,700	1000
Natural gas	20,000	200,000	600	1,600	500
Electrified accessories	15,000	137,800	400	1,500	600
Battery-electric	6,000	7,200	-	-	33
Fuel cell	6,000	22,600	-	-	77
Total	88,000	610,000	2,100	5,800	2,200

Potential ZEB Timeline Scenario

- Proterra electric bus validated to industry w Foothill and others 2012/13
- New bus purchases grow from 10's to 25 Plus and delivered in 2014/2015
- Major bus OEMS may offer products in 2017
- 100-500/year ZEB's starting in 2018
- 6000 Cumulative by 2030

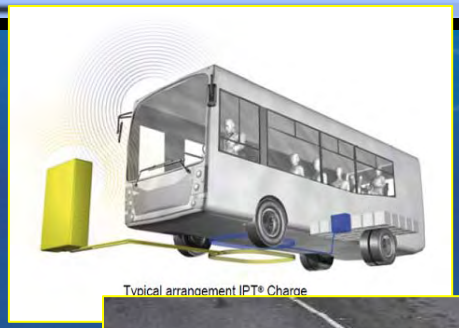
Differing Battery Bus Strategies May Emerge

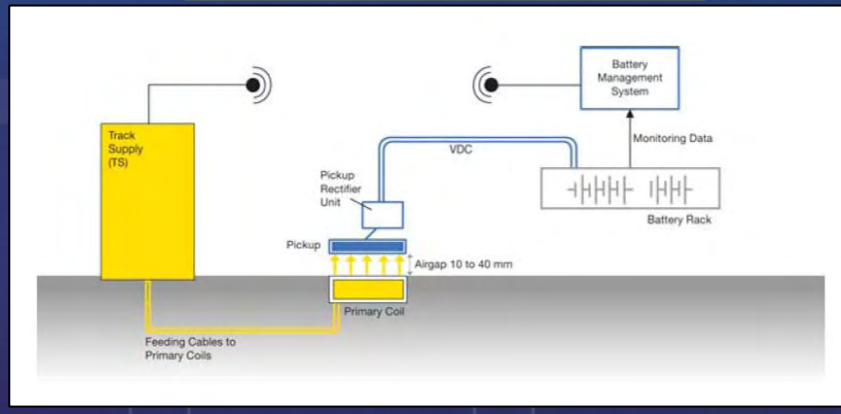
- Proterra Bus- 18Kwhrs -30 Mile range and Hi-Power Opportunity Charging

- DesignLine (estimated 60Kwrs Zebra), 100 mile range and periodic charging-Overnight or between shifts

Alternative Charging Connections

- Wampfler IPT Inductive Charging
- 30 KW Coupler- Up to Two per Bus
- FTA Testing with University of Tennessee
- 20 Buses operating in Turin Italy
- US NAVY looking at a demonstration Project





A Need for Research on Topologies That Reduce Periodic Hi Power Demand

CALSTART Selected and funding Washington State to demonstrate slower energy retransfer module to reduce peak loads

- **Uses basic charger at 30 to 60kwatt rate capability**
- **Off board battery packs charged up to 60 kwhrs overnight or over a one hour period**
- **Off board battery pack charges the on board battery packs**
  - **Periodic Opportunity Charging / once per hour anticipate requiring at 180kw rate for five to ten minutes**
- **Allows for all day operation**

"Zero Emission Bus Program"
We Need Your Support

- ISTEA $12 million Advanced Transportation System and Electric Vehicle Research and Development Consortia
- DARPA $130 million Electric and Hybrid Vehicle Technology Program
- TEA-21 $300 million Advanced Vehicle Technologies Program
- SAFETEA-LU $60+ million National Fuel Cell Bus Technology Initiative
- NEXT-TEA $150 million Zero Emission Bus Program

"Zero Emission Bus Program"
A National Program to Advance Zero Emission and Energy Security

A Coalition backed 6 year, $150M Program

- ***Extend the success of National FC Bus Program and continue efforts to commercialize zero-emission fuel cell buses***
- ***Support new and Emerging Zero like the battery bus technology***
- ***Seek to advance extremely Low Carbon Type alternative fuel hybrids***
- ***Proposes***
  - ***A reduced cost share of 20% vs. the existing 50%***
  - ***Funds to support Refueling and Infrastructure***
  - ***Funds also to includes needs for logistics & spares***

Supporters to Date of $150M ZEB Program in Next TEA Bill

CALSTART

EMP POWERING THE FUTURE

AIR PRODUCTS

BAE SYSTEMS

BALLARD

TRANSPOWER THE POWER TO MOVE PEOPLE.

AC TRANSIT

HYDROGENICS Advanced Hydrogen Solutions

PROTERRA COST-EFFECTIVE SOLUTIONS FOR CLEAN TRANSPORTATION

DOW KOKAM

AQMD

ISE Transportation recharged.

Linde

Foothill Transit

NEW FLYER

Trillium Making CNG Work for You

LYNX

SunLine TRANSIT AGENCY

UTC Power A United Technologies Company

Supporters as of (10/21/10)

Join the team!

fsilver@calstart.org

VISION motor corp

US Hybrid Mobile Energy Technologies

CT TRANSIT

Questions?

Clean Transportation Technologies and Solutions SM

CALSTART

www.calstart.org

Electric Transit Bus Charging Station

Foothill Transit

GOING GOOD PLACES

George Karbowski
Director of Operations and Maintenance
Foothill Transit

Electric Power Research Institute
March 2-3, 2011
San Diego, California

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Foothill Transit: A Joint Powers Authority

Foothill Transit
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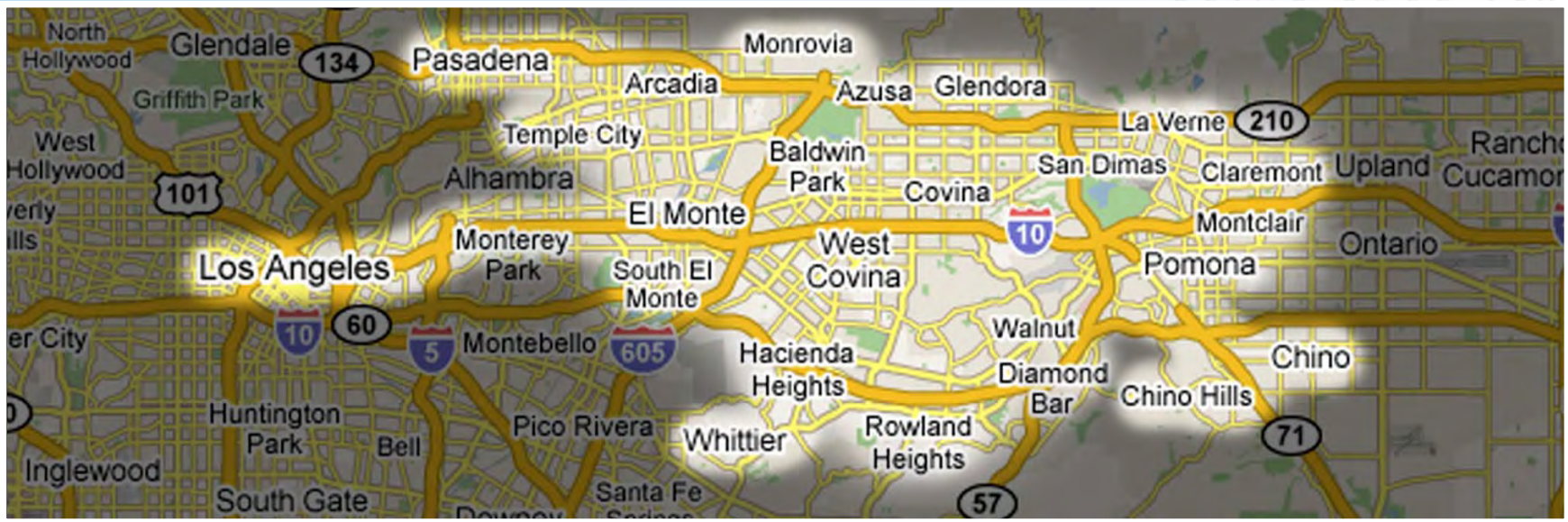

327 Square miles served

15 Million passengers per year

33 Fixed-route bus lines

300 Buses

CARB ZEB Regulation

Foothill Transit
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California Air Resources Board (CARB):
"15% of new bus purchases must be Zero Emissions beginning in 2012."

ecoliner
Zero Emissions Electric Vehicle

American Recovery and Reinvestment Act

Foothill Transit
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ARRA 2009

- $1.2M per bus (3)
- $1M per charger (2)
- $6.5 M TOTAL funding

$10.17 M Awarded through TIGGER II

Foothill Transit

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DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

Nine additional Ecoliner buses will fully electrify Line 291

Total of 12 Ecoliners

Supplemental Funding

Foothill Transit

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California Energy Commission (CEC)

$200K

Mobile Resource Air Pollution Reduction Committee (MSRC)

$85K

South Coast Air Quality Management District (SCAQMD)

$290K

The Foothill Transit Ecoliner Project

Foothill Transit
GOING GOOD PLACES

- Zero Emissions
- Potential for 90% reduction in fuel costs
- Lower maintenance costs
- Ultra-quiet drive system
- Up to 90% regenerative braking recapture

The Proterra Bus

Foothill Transit
GOING GOOD PLACES

- ❖35 feet long, 102" wide, 11' 2" high
- ❖Composite body w/ Rear window
- ❖Lightweight—28,000 lbs. GVW
- ❖Low floor, two door design
- ❖Multiplex electrical system
- ❖All electric accessories
- ❖Turning radius – 44 feet
- ❖35 passenger seats
- ❖Light Emitting Diode (LED) lighting
- ❖All wheel disc brakes w/ Regenerative braking
- ❖Meets FTA Buy America standards
- ❖Lithium-Titanate battery
- ❖10 minute complete fast-charge
- ❖Battery capacity – app. 74 kWh @ 368 volts

Advantages of a composite body:

Foothill Transit
GOING GOOD PLACES

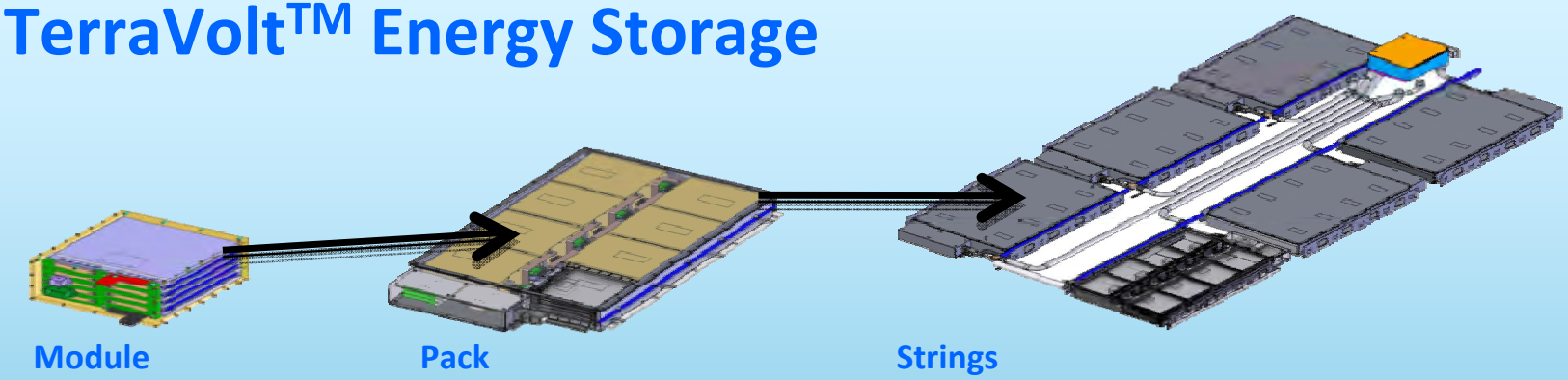
- Improved safety with crash resistant composite structure
- Non-Conductive structure eliminates potential for High Voltage Ground Fault to body
- Less costly to maintain than conventional metal bodies; no corrosion
- 40%+ longer life
- 20-40% weight reduction

The Altairnano Batteries

Foothill Transit
GOING GOOD PLACES

- Eight battery packs, each with eight 1.1 kW-hr battery modules
- Four parallel strings, each containing two packs and 16 battery modules
- Nominal 368 volts
- Parallel strings are independently fused
- 10 serially connected modules
- 23.0 volt, 50 Amp-hr Nano Lithium-Titanate cells
- Lithium-Titanate battery chemistry can accept a rapid charge
- Charging accomplished in less than 10 minutes

TerraVolt™ Energy Storage



What makes this bus different?

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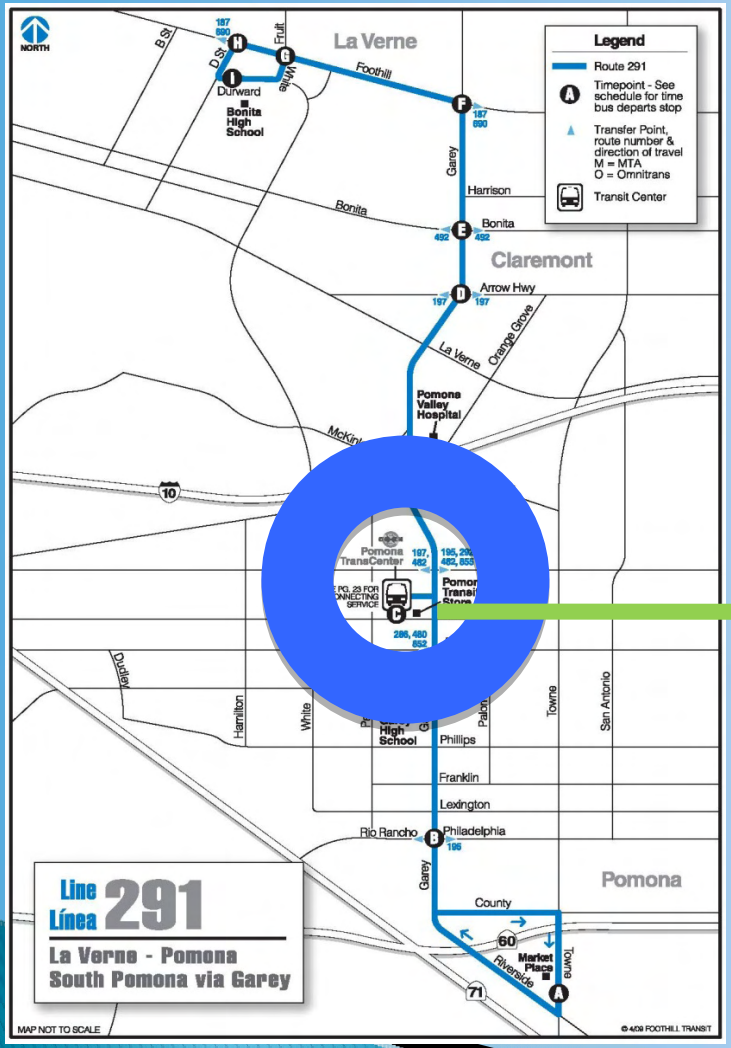
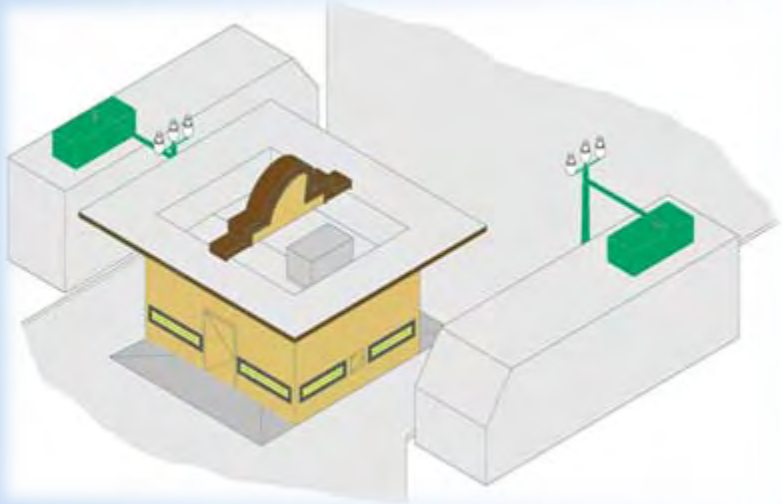


The Fast Charge System



The AeroVironment Chargers

Foothill Transit
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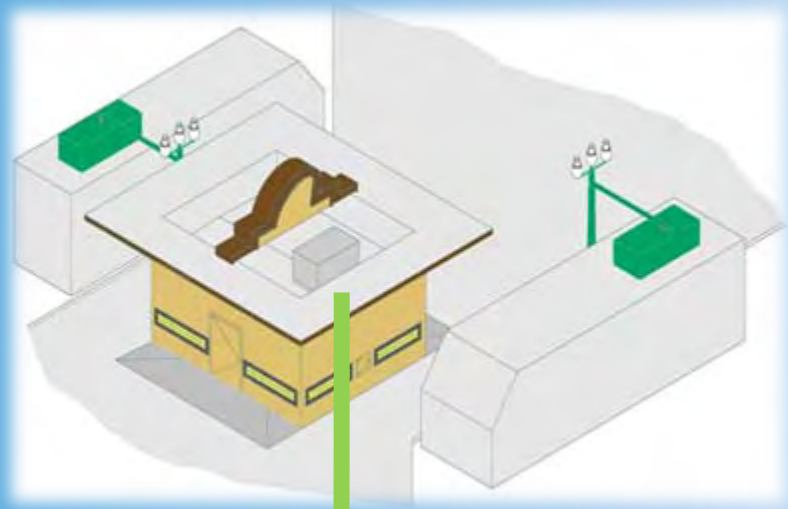

Two Pair of 250 kWh Chargers

The Proterra Fast-Charge Station

Foothill Transit
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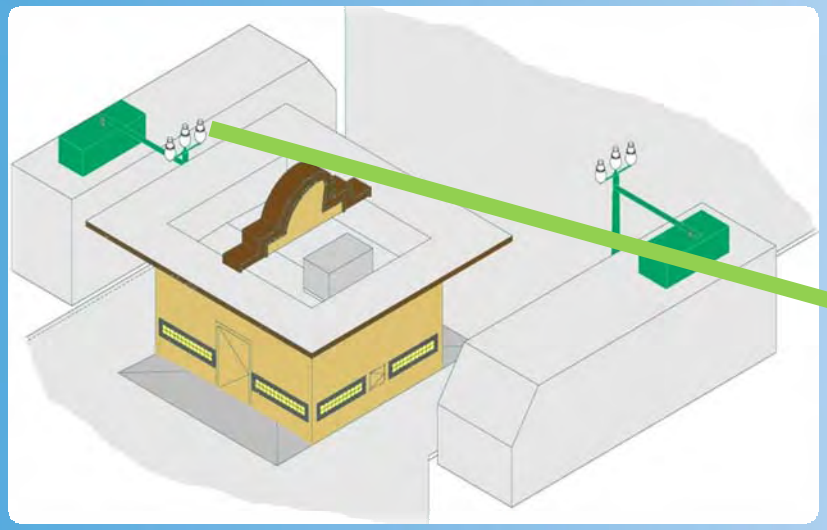

Automatic Docking Sequence

Potential 1MegaWatt Peak Demand

400% increase in Fuel Economy

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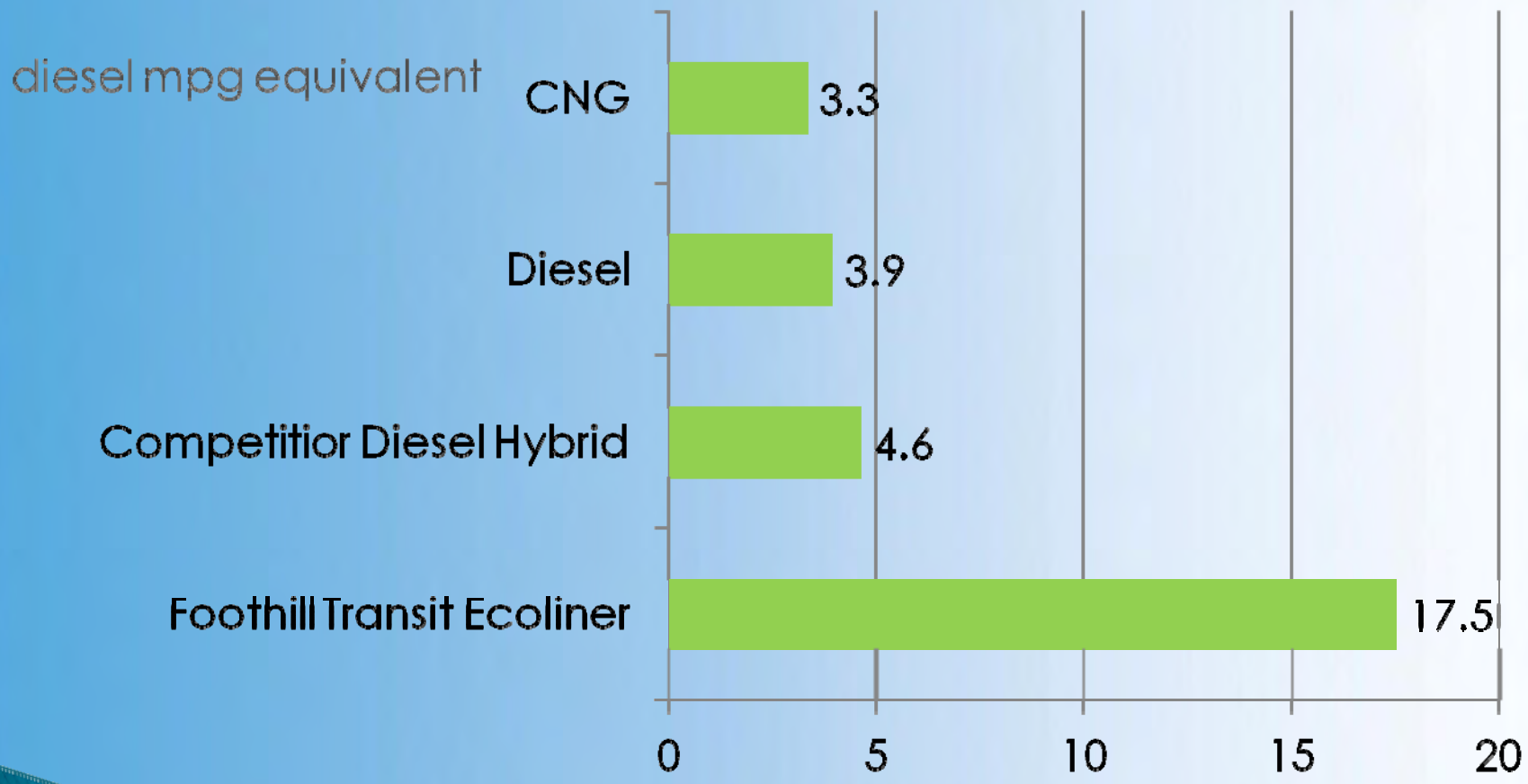

Renewable Energy

Foothill Transit
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Department of Energy (DOE)
Renewable Energy Credits (REC's)

CERTIFIED RENEWABLE ENERGY ®

Green-e.org

Energy Use

Foothill Transit
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Monthly energy breakdown for one Ecoliner

Month	Season	Energy Use (kWh)	Base Energy Cost	Demand Charge	Total Energy Cost
January	Winter	6925.5	$558.08	$1,095.58	$1,653.66
February	Winter	6294.5	$511.14	$1,095.58	$1,606.72
March	Winter	7001.4	$571.78	$1,095.58	$1,667.36
April	Winter	6765.7	$551.57	$1,095.58	$1,647.15
May	Winter	6925.5	$558.08	$1,095.58	$1,653.66
June	Summer	6906.9	$610.43	$3,308.07	$3,918.50
July	Summer	7068.7	$620.92	$3,308.07	$3,928.99
August	Summer	7068.7	$620.92	$3,308.07	$3,928.99
September	Summer	6906.9	$610.43	$3,308.07	$3,918.50
October	Winter	6925.5	$558.08	$1,095.58	$1,653.66
November	Winter	6765.7	$551.57	$1,095.58	$1,647.15
December	Winter	7001.4	$571.78	$1,095.58	$1,667.36
TOTAL	**NA**	**82556.4**	**$6,894.75**	**$21,996.93**	**$28,891.68**

Energy Cost Per Mile Comparisons

Foothill Transit
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Electric Bus		
(with demand charges) Energy cost /bus/mile	**$0.73**	**(without demand charges)** **$0.17**
CNG Bus		
(*With subsidies) CNG cost /bus/mile	**$0.50**	
Diesel Bus		
Diesel cost / bus/mile	**$0.85**	

Fully Electrified Line 291

Foothill Transit
GOING GOOD PLACES

Monthly Breakdown 12 buses	Season	Energy Use (kWh)	Base Energy Cost	Demand Charges	Total Energy Cost
January	Winter	83106.3	$6,696.92	$1,906.41	$8,603.33
February	Winter	75533.5	$6,133.69	$1,906.41	$8,040.10
March	Winter	84016.4	$6,861.33	$1,906.41	$8,767.74
April	Winter	81188.7	$6,618.78	$1,906.41	$8,525.19
May	Winter	83106.3	$6,696.92	$1,906.41	$8,603.33
June	Summer	82882.9	$7,325.17	$6,331.39	$13,656.57
July	Summer	84824.2	$7,451.02	$6,331.39	$13,782.41
August	Summer	84824.2	$7,451.02	$6,331.39	$13,782.41
September	Summer	82882.9	$7,325.17	$6,331.39	$13,656.57
October	Winter	83106.3	$6,696.92	$1,906.41	$8,603.33
November	Winter	81188.7	$6,618.78	$1,906.41	$8,525.19
December	Winter	84016.4	$6,861.33	$1,906.41	$8,767.74
TOTAL	**NA**	**990676.8**	**$82,737.06**	**$40,576.85**	**$123,313.91**

Challenges

Foothill Transit
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- **Bus Development**
  - ✓ Reliability and Durability Goals
  - ✓ Life cycle cost model
- **Charger Development**
  - ✓ Reliability and Durability Goals
  - ✓ Maximize use of infrastructure
  - ✓ Operational requirements / Redundancy
- **Energy Requirements**
  - ✓ Renewable Energy
  - ✓ Buy America Goals
  - ✓ Demand charge challenges
- **Industry Acceptance**
  - ✓ Where are we headed

What does this mean?

Foothill Transit
GOING GOOD PLACES

Demand Charges are a game changer!

Questions?

Foothill Transit
GOING GOOD PLACES

George Karbowski

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IEC Project Stages and Timetable for Standards Development.

Project Stage	Associated Document Name	Abbreviation	Minimum Timeline (for comment and/or voting)
Proposal stage	New Work Item Proposal	NP	3 months for voting
Preparatory stage	Working draft	WD	12 months recommended
Committee stage	Committee draft	CD	2-4 months for comment
Enquiry stage	Enquiry draft	IEC/CDV	5 months for comment and voting
Approval stage	Final Draft International Standard	FDIS	2 months for voting
Publication stage	International Standard	IEC or ISO/IEC	1.5 months

IEC – High Voltage Shore Power Equipment

International Electrotechnical Commission (IEC) Technical Committee No. 18

IEC TC18 MT26 - IEC/ISO/IEEE 60092-*510* ►
NOW IEC/ISO/IEEE 80005

- Part 1: Cold Ironing - High Voltage Shore Connection (HVSC) Systems – General requirements
- Part 2: Cold Ironing - High Voltage Shore Connection (HVSC) Systems – Communication Interface Description

Last meeting November 2010 – Berlin, Germany

IEC/ISO/IEEE 80005-1 Cold ironing Part 1: High Voltage Shore Connection (HVSC) Systems - General requirements
All comments have been answered.
Status: IEC CO preparing CDV Voting Document

IEC/ISO/IEEE 80005-2 Cold ironing Part 2: High Voltage Shore Connection (HVSC) Systems - Communication Interface Description
Status: New Work Proposal (Document 18/1201/NP)

International Electrotechnical Commission (IEC) Sub-Committee SC23H

IEC 62613, Plugs, Socket-Outlets, Ship Connectors And Ship Inlets For High-Voltage Shore Connection Systems, (HVSC-Systems)

Part 1: *General requirements*. Contains constructional and test requirements for both 7.2kV and 12 kV plugs, socket-outlets (receptacles), connectors and ship inlets.

Status: CDV has been accepted, sent to IEC CO for preparation of FDIS in January

Part 2: Interchangeability requirements for accessories to be used by various types of ship

Status: Product drawings received, sent to IEC CO for publication of CDV in February