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Wireless Charging Infrastructure for Battery Electric Buses in Public Transportation

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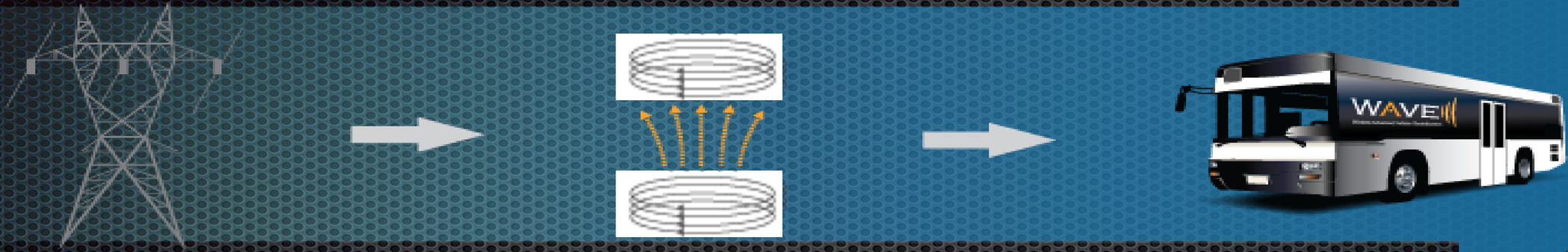
WAVE
Wireless Advanced Vehicle Electrification

Electrified Bus Transportation | WAVE Solutions



Electric Grid Wireless Charger Vehicle

WAVE Technology:

- Safe Power Transfer through Road & Weather
- Fast Charging
- Large Air Gap – No Mechanical Movement
- Efficient > 90%

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Electrified Bus Transportation | WAVE Solutions

Problem	Limited Range & Anxiety	Ugly & Unsafe	Expensive & Heavy Batteries	Impractical
WAVE Solution	• In-Route Wireless Charging • Charge at Stops • Double the Range	• Low Profile • Invisible Infrastructure • Hide It Underground	• Carry Less • Reduces Vehicle Weight • Improves Efficiency	• No Hulking Wires • Never Plug In • Automated

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WAVE Wireless Charging | Metro McAllen TX

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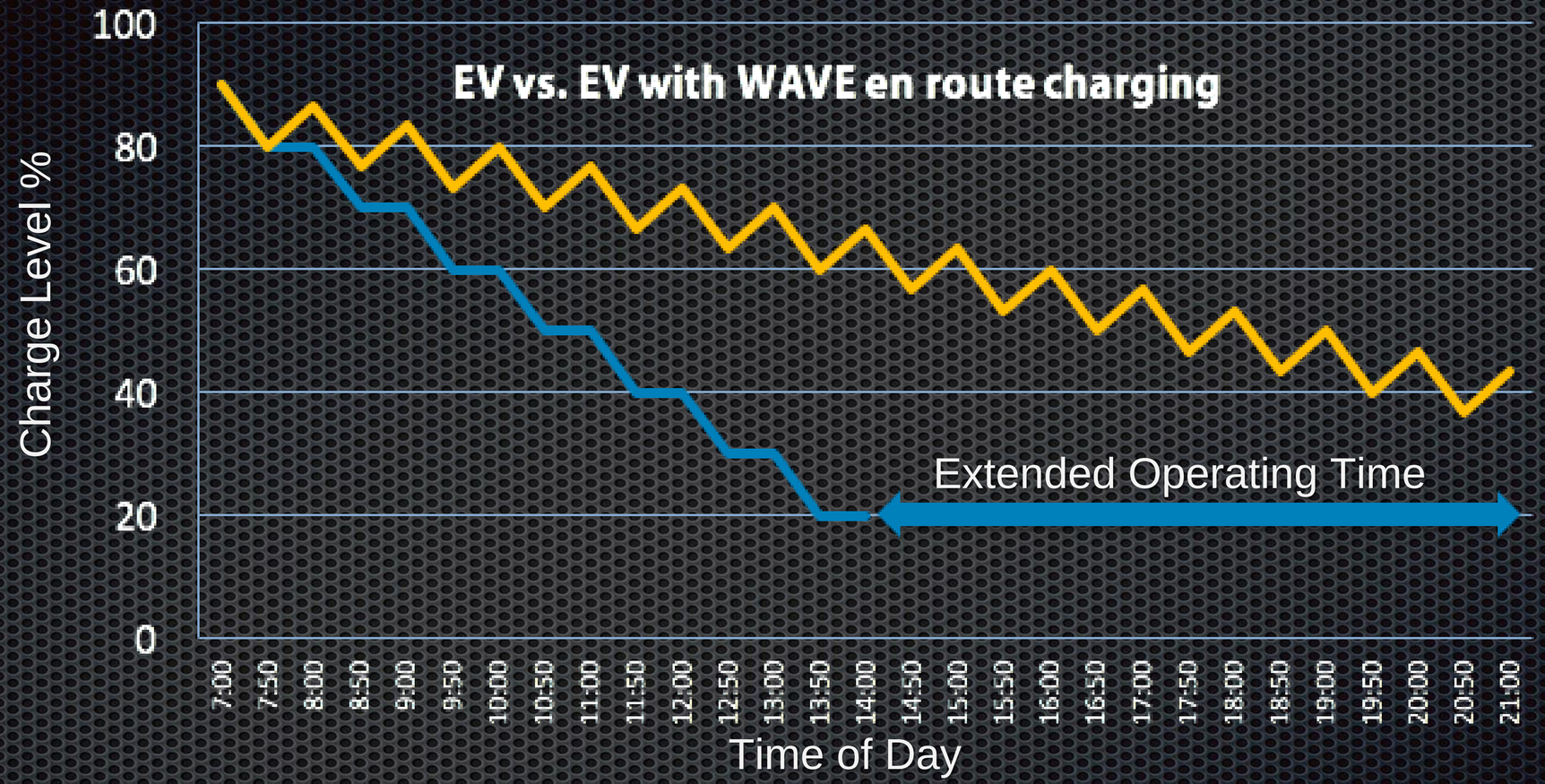
Opportunity Charging | Range Extension



"The charging pad is positioned at the bus terminal for layovers, which are typically about 10-15 minutes, and during this time the bus will be charging," Mario Delgado, City of McAllen Transit Director

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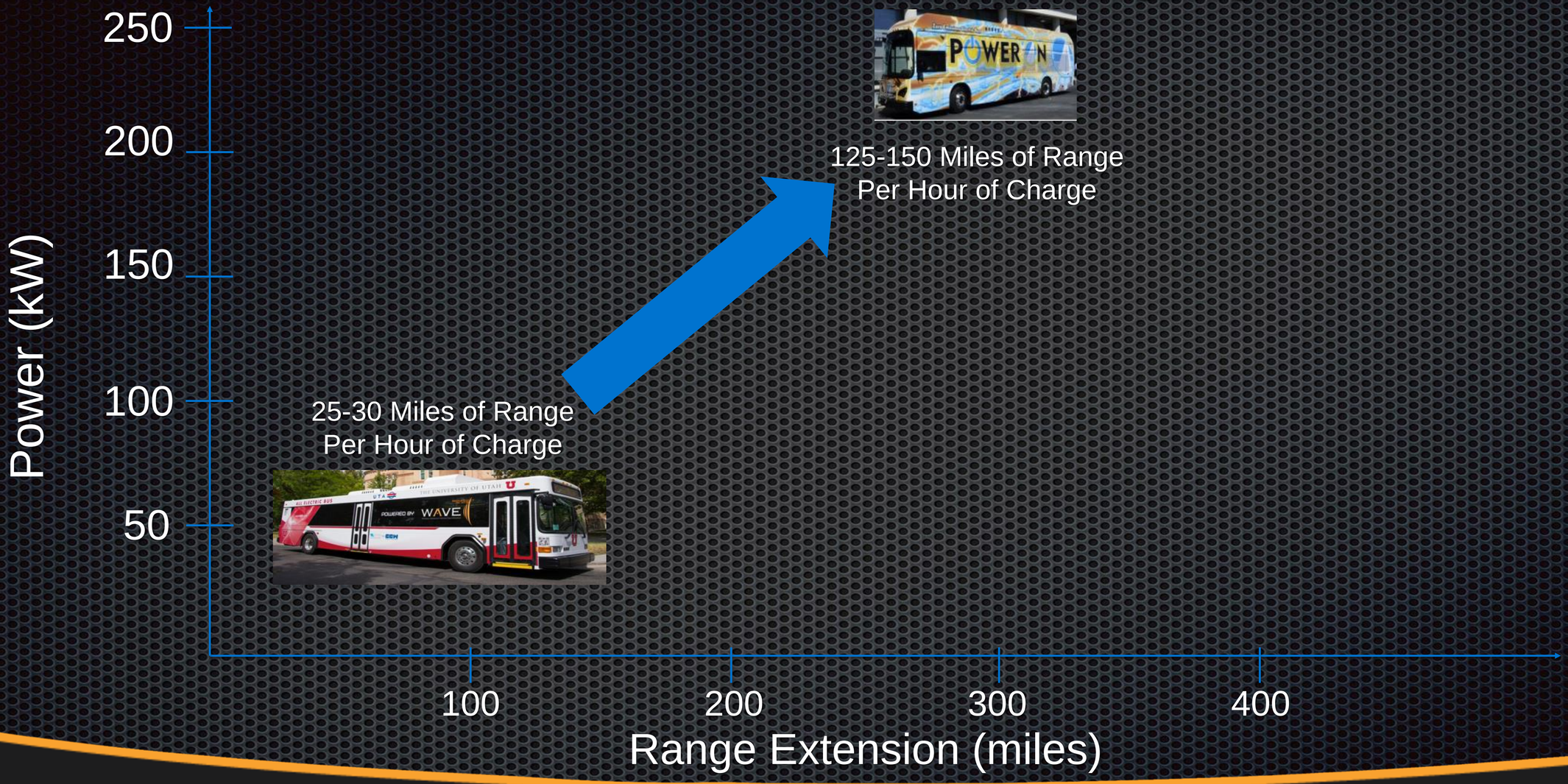
Range Extension | Increased Charging Power Level



Wireless Charging vs. Overhead Charging

Wireless Charging

Overhead Conductive Charging

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Commercial Deployments

In-Service

In Progress

Sustainable

CALIFORNIA ENERGY COMMISSION

South Coast AQMD

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1st US Fleet 100% Battery Electric | 250kW

In-Route Charging

Depot Charging

WAVE 250kW Wireless Charging


TECHNOLOGY

WAVE Demonstrates 250kW Wireless Power Transfer System

SOURCE: WAVE INC. FEB 23, 2017

WAVE

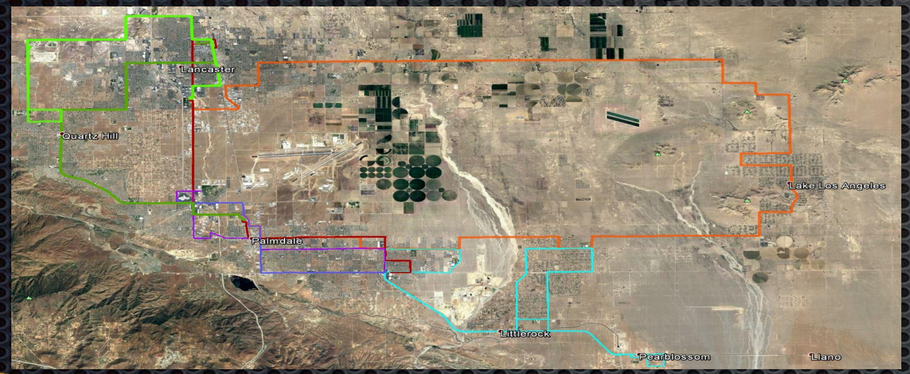
WAVE Demonstrates Industry Leading 250kW WPT System

WAVE

250kW Wireless Power Transfer System.

Photo credit: *WAVE*

Route Planning



BYD 60ft Artic

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Full OEM Vehicle Integration

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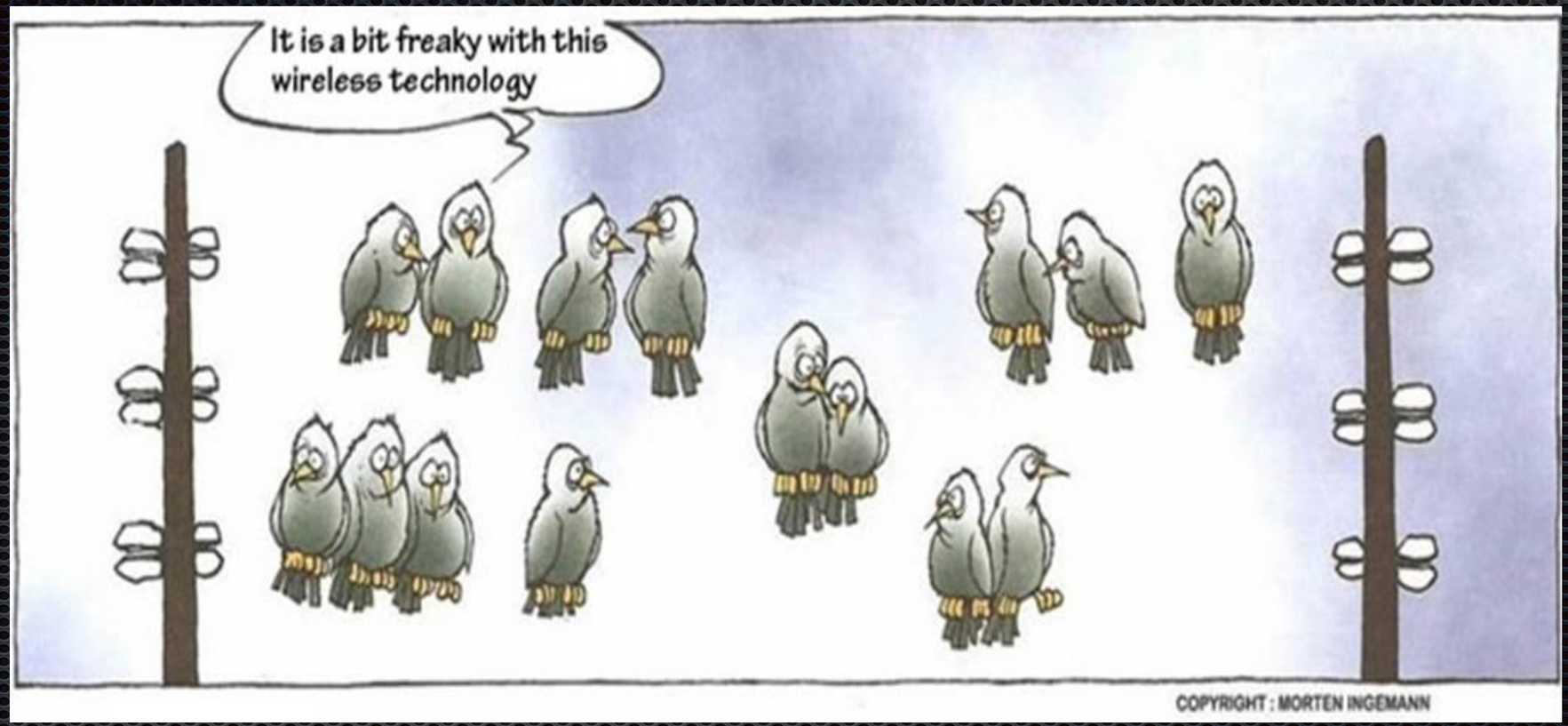
Wireless | Freaky & Scary?



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Product Safety Certifications

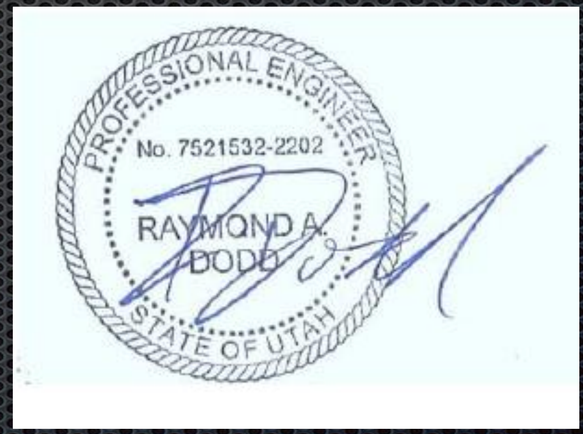
Safety Certification

Underwriters Laboratories Inc.®

Magnetic Field Exposure

ANSI
American National Standards Institute

AAMI
Celebrating Fifty Years of Building Tomorrows



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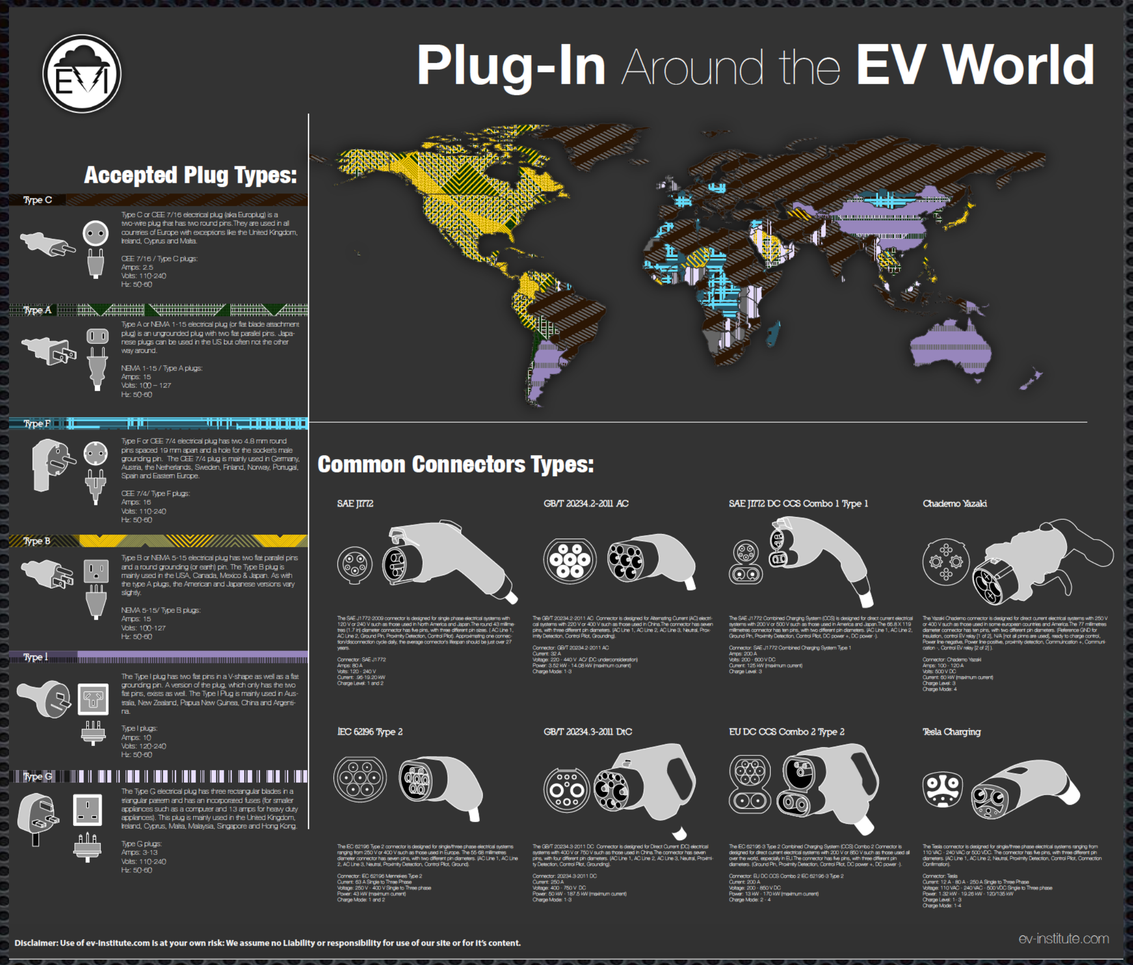
The Plug-In Nightmare!!! | Can Wireless Charging Avoid This?



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SAE J2954 Taskforce Structure: OEM/ Supplier Co-Chairs

J2954 OEM Advisory Team

J2954 Taskforce Chair
Jesse Schneider

Alignment Methods & * Communication
Co-Chairs:
D. Burkett– Ford
K. Sealy – Witricity

Testing & Validation
Co-Chairs:
M. Abdul-Hak – Daimler
Jon Sirota – Witricity

Magnetic Field Interoperability
Co-Chairs:
I. Teerlinck – Toyota
G. Covic – University of Auckland

UL 2750 / SAE J2954 Joint Team**
Co-Chairs:
J. Bablo – UL
E. Taha – Nissan

Bus /HD Charging SAE J2954-2
Co-Chairs:
N. Vågstedt – SCANIA
M. Masquelier – WAVE

EMC /EMF
Co-Chairs:
R. Kautz – Ford
R. Sutton – TDK
R. Boyer – Delphi

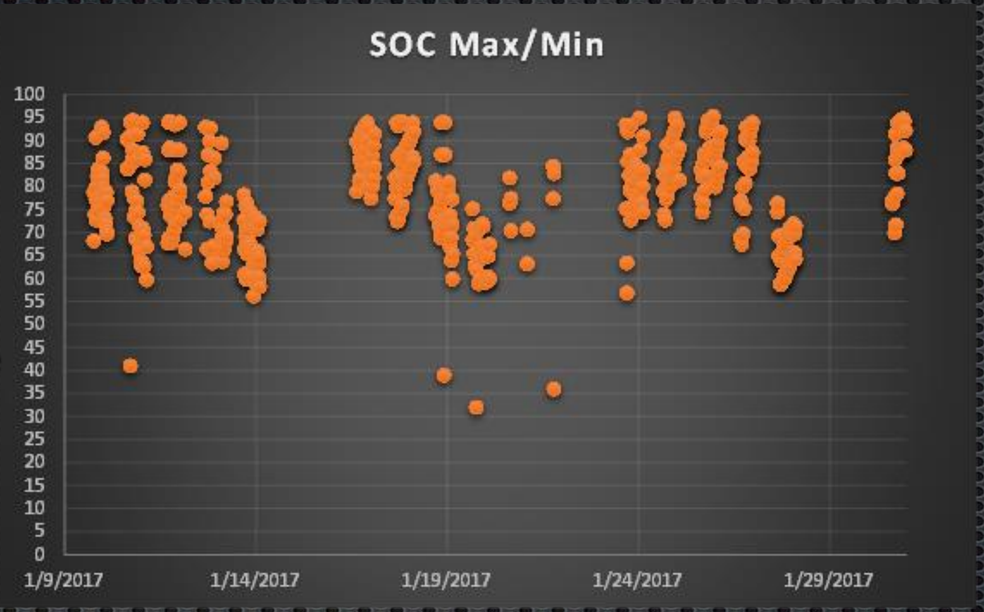
Liaisons:
ISO**/IEC : J. Sirota (Witricity)/ I. Teerlinck (Toyota)
SAE EMC Committee: R. Kautz (Ford) / R.Boyer (Delphi)
AAMI/ ANSI/CISPR: R. Boyer (Delphi) / Sutton (TDK RF)
FCC/FDA: Schneider / Kautz / Sutton / Boyer

*In Coordination with ISO & SAE Hybrid Communications & DSRC Committees
**SAE J2954 MOU with UL established. ISO MOU under discussion.

Event Notification | Real-Time SOC & Consumption

Data Monitoring:

- ✓ Real-Time SOC
- ✓ kWh Capacity (Range)
- ✓ Real-Time Consumption
- ✓ Battery Depth of Discharge



Event Notification:

- ✓ SOC Drops below Threshold
- ✓ Can't Make it Back to Depot
- ✓ Driver Differences
- ✓ Battery Capacity Fade

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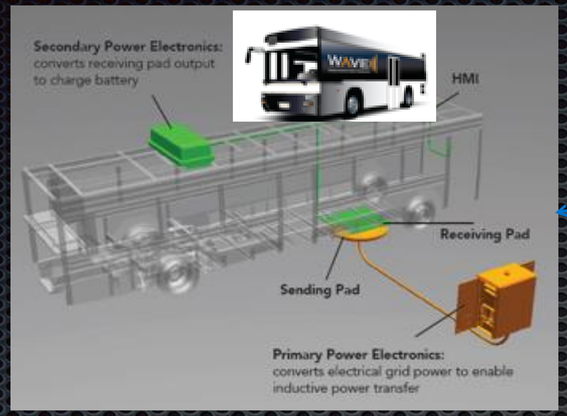
Energy Storage Balance | A Juggling Act



Haul It

Feed It

Store It

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Technology Costs | Wireless vs. Wired

- Inductive vs. Conductive
- Unknown Costs of Conductive Charging
- Case Study:
  - Connection Time
  - Cable Damage
  - Connector Failures
- Cable Theft

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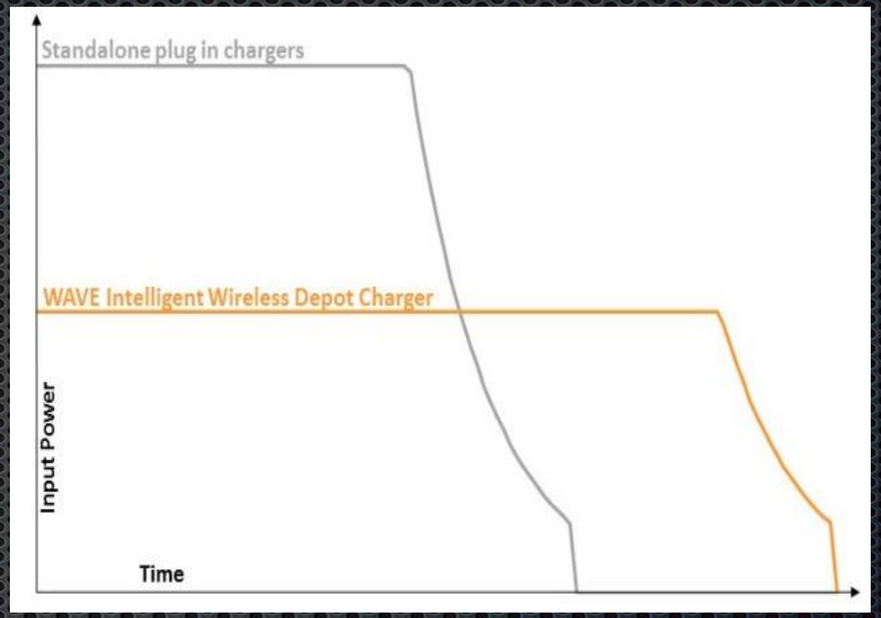
Wireless Depot Charging | No More Plugs

No Plugs

- Convenience of in-route wireless charging at the depot
- 50-250kW per bus
- No connectors or cables to maintain, no HVDC to handle.
- One Depot Charger can serve up to 12 buses

Charge Smart



- Eliminates need for multiple on-board chargers
- Intelligent charging levels utility loads to reduce peak demand
- Just in time charging maximizes battery life
- Adjustable loading to avoid paying peak electricity rates

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Interoperability | Shared Charging Infrastructure

Interoperability