Charging ahead
GE EV Solutions

IEEE – NYC Chapter
February 22, 2011

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Electric Vehicle Marketplace
Motivation To Embrace Electric Vehicles

Domestic Policy Goals
- Reduce dependence on foreign oil
- Job creation
- Economic Growth (energy sources local)

Global Impact
- Europe to mitigate climate change
- China to balance growth with pollution
- Governments around the world have allocated funding for clean technology

Energy Independence
- Local energy sources reduce price volatility
- Reduce export of dollars, particularly to unstable regions of the world
- Reduce dependence on few key regions – roughly half of the EU’s gas consumption comes from only three countries (Russia, Norway, Algeria)

Developing Nations
- Lower-cost conventional vehicles support economic development goals.
- Urban air pollution and rising oil imports to be the main driver of electrification
- China has stated its goal of reducing the carbon intensity of its economy.
- Lack of Infrastructure (grids) is a huge factor.

Climate Change
- Global support for climate change has gained momentum with Europe leading the way.
- Transportation accounts for roughly 15% of energy related CO2 emissions globally.
- In 1992, the United States ratified the United Nations’ Framework Convention on Climate Change (UNFCCC), which called on industrialized countries to make voluntary efforts to reduce greenhouse gases.
- EU energy policy provides affordable energy while contributing to the EU’s wider social and climate goals.
EV Is Becoming An Economic Reality

- Electric vehicles emit zero tailpipe emissions at the point of use. The carbon footprint of electric vehicles is approximately 30% better than that of conventional vehicles, even when the electricity used is produced by a coal-fired power station.
- Total Cost of Ownership (TCO) will become increasingly favorable as the price of fuel rises in the future. Current global economic conditions will drive how quickly fuel prices begin to appreciably rise and influence the TCO of various models (ICE, Hybrid, PHEV, EV).
For every EV sold, we expect there will be demand for 1.4 charging stations

Source: Department of Energy Report (Feb 2011)
Electrical Vehicles Are Coming...

- **Sport/Luxury**
  - Tesla Roadster
  - Porsche 918 PHEV
  - Audi A1 PHEV
  - Fisker Karma
  - Volvo V70 PHEV

- **Compact**
  - Mini EV
  - Zenn EV
  - Wheego LiFe
  - Mitsubishi i-MiEV
  - Smart for two
  - Think City
  - Toyota Prius
  - Honda Insight PHEV

- **Light Trucks, Sedan/SUV**
  - GM Volt
  - Nissan Leaf
  - Coda EV
  - Toyota Rav4 EV
  - BYD e6 EV
  - Ford Focus EV
  - Smith Electric
  - Navistar eStar
  - Ford Transit Connect
  - Mercedes Vito E-cell
  - Renault Kangoo
  - Bright Auto Idea

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GE imagination at work
Fundamental Transformation

**Auto OEM**
- Ford
- GM
- Toyota
- Volt
- Smith

**Fuel Production**
- Shell
- Exxon
- Xcel Energy
- Duke Energy

**Fueling Location**

**Data Collection**

**Vehicle Sales**

**Gasoline**

**Electric**

**EV Tax Credits**
- Leaf, Volt
- Prius, Focus
- Escalade, Caravan

**150K+ EVs built in U.S. (Ford, GM, Nissan)**

**25% of new vehicles electric***

**90% of new vehicles electric by 2030***

* Needed to achieve Electrification Coalition goal of 75% electric miles by 2040
GE provides the electrical infrastructure to support charging station infrastructure.
Key Drivers for EV Growth

1. Government Funding and Incentives

2. Auto Manufacturer EV Pipeline

3. The Environmental Consumer
#1 Federal Government Activity

1. **American Recovery and Reinvestment Act (ARRA) Funding – $2.4B for manufacturing and infrastructure**
   - $1.5B for US-based manufacturers to produce batteries and EV components
   - $500MM to produce other EV components like motors
   - $400MM to demonstrate and evaluate PHEV and related infrastructure

2. **Auto Manufacturer Incentives - $8B loans for Advanced Vehicle Technologies**
   - $5.9B to Ford (factories in Ohio, Illinois, Kentucky, Michigan, Missouri, Ohio)
   - $1.6B to Nissan (factory in Tennessee)
   - $465MM to Telsa (factory in California)

3. **Fuel Efficient Vehicles Tax Incentives for Consumers**
   - Tax credit for EV’s, up to $7,500
   - Tax credit for charging stations up to $2,000 for consumers and $50,000 for public charging or 50% of the cost
   - Final guidance is pending the issuance of EV regulations
# Legislative Update

<table>
<thead>
<tr>
<th>State</th>
<th>Type</th>
<th>Incentive</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federa l</td>
<td>Credit</td>
<td>ARRA 2009.</td>
<td>$7,500</td>
</tr>
<tr>
<td>Federa l</td>
<td>Credit</td>
<td>Charging Station: 30% of charging station cost.</td>
<td>Up to $1,000</td>
</tr>
<tr>
<td>CA</td>
<td>Purchase rebate</td>
<td>BEV (&lt; $5,000). PEV ($3,000). Various discounted utility rates for electricity used to charge EVs.</td>
<td>$3,000 - $5,000</td>
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<tr>
<td>TX</td>
<td>Cash grant</td>
<td>The Texas Light Duty Motor Vehicle Purchase or Lease Incentive Program reimburses the purchase or lease of an eligible new on-road light-duty motor vehicle.</td>
<td>Determined by type of vehicle</td>
</tr>
<tr>
<td>FL</td>
<td>Exemption</td>
<td>EVs are exempt from most insurance surcharges.</td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>Purchase rebate</td>
<td>Purchase of qualified new EV, (&lt; 6 months after purchase date).</td>
<td>$500</td>
</tr>
<tr>
<td>NJ</td>
<td>Exemption</td>
<td>Sales of zero emission vehicles are exempt from sales tax.</td>
<td></td>
</tr>
<tr>
<td>NY</td>
<td>Credit</td>
<td>Available for installation of alternative fuel vehicle fueling infrastructure located in the state.</td>
<td>50% of cost</td>
</tr>
<tr>
<td>IL</td>
<td>Credit</td>
<td>The Alternative Fuel Vehicle and Alternative Fuels Rebates Program provides rebates of 80% of approved incremental costs for purchase of a new alternative fuel vehicle.</td>
<td>Up to $4,000</td>
</tr>
<tr>
<td>GA</td>
<td>Credit</td>
<td>Income tax credits (&lt; 20% of EV cost)</td>
<td>Up to $5,000</td>
</tr>
</tbody>
</table>

**2010 CAFE standard:** 34.1 MPG by 2016 or ~250 grams CO2 per mile.
#1 DOE Clean Cities Initiative

- DC-based initiative of the DOE’s Office of Energy Efficiency and Renewable Energy
- Over 90 coalitions established with 6,500 stakeholders from both the public and private sectors
- Coalitions supporting various clean technologies, including EV infrastructure

### United States Map with Cities

- Western New York: Genesee Region
- Central New York
- Capital District
- Vermont
- Granite State
- Maine
- Massachusetts
- Ocean State
- CT (4 cities)
- Delaware
- New Jersey
- NYC
- Long Island
- Maryland
- DC
#2 Auto Manufacturer Activity

**Battery Electric Vehicles (BEV):**
- 2010 Coda Automotive Sedan
- 2010 Mitsubishi iMiEV BEV
- 2010 Nissan LEAF
- 2010 Ford Battery Electric Van
- 2010 Tesla Roadster Sport EV
- 2010 Chevy Volt Extended Range EV
- 2011 Peugeot Urban EV*
- 2011 Renault Kangoo Z.E.
- 2011 Renault Fluence Z.E.
- 2011 Tesla Model S
- 2011 BYD e6 Electric Vehicle
- 2011 Ford Battery Electric Small Car
- 2011 Opel Ampera Extended Range*
- 2012 Fiat 500 minicar
- 2012 Renault City Car*
- 2012 Renault Urban EV*
- 2012 Audi e-tron
- 2013 Volkswagen E-Up*
- 2016 Tesla EV

**Hybrid Electric Vehicles (PHEV):**
- 2010 Lexus HS 250h
- 2010 Mercedes E Class Hybrid
- 2010 Porsche Cayenne S Hybrid
- 2010 Toyota Camry Hybrid
- 2010 Toyota Prius Hybrid
- 2011 Audi A8 Hybrid (likely introduction)
- 2011 BMW 5-Series ActiveHybrid
- 2011 Honda CR-Z sport hybrid coupe
- 2011 Lexus CT 200h Hybrid Hatchback
- 2011 Peugeot Diesel Hybrid*
- 2011 Suzuki Kizashi Hybrid
- 2011 Audi Q5 Crossover Hybrid
- 2011 Hyundai Sonata Hybrid
- 2011 Infiniti M35 Hybrid
- 2014 Ferrari Hybrid

Source: [www.electricdrive.org](http://www.electricdrive.org)

*European Launch
#2 Auto Manufacturer Launch Cities

- Nissan Leaf
- GM/Chevy Volt
- Toyota Plug-In Prius
- Toyota Plug-In Prius
- BMW Mini E
- Ford Plug-In Focus

Source: auto manufacturer web sites & press releases
#3 The 3 Core Consumer Mindsets

- **Environmentally Conscious**: 47%  
  - For this consumer, an EV at the right price point and form factor will be an obvious investment. They see the benefits and consider themselves part of the environmental movement: driving an EV will demonstrate that commitment.

- **Technology and Car Driven**: 47%  
  - The innovative design, fast charging, and cool display will entice these drivers - they'll be intrigued by electric cars as a technology item first and foremost, so design cues and feature sets that reference other high tech brands will stand out.

- **Frugal Travelers**: 35%  
  - These consumers are driven more by the money that comes out of their wallets. While some are concerned about the total cost of ownership, the main pain point is how much they pay at the pump each visit. Reducing those charges by 2/3s is highly compelling.

**Political Arguments**

- Regardless of need, everyone wants to see America’s dependence on oil (particularly foreign oil) reduced.
Survey of Global Initiatives

**Americas**

**United States**
Offers up to $7,500 for qualified vehicles (Chevrolet Volt, Nissan Leaf, Coda sedan, Tesla Roadster). $2.8 billion overall budget allocated.

**Canada**
Plans to have 1 in 20 vehicles driven in Ontario to be electrically powered by 2020. Quebec offers up to $8,000.

**Mexico**
Mexico City signed an agreement with Nissan to deliver recharging infrastructure for EVs in 2011.

**Brazil**
Plans to develop electric vehicles and build solar-powered charging stations in near future.

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**Europe**

**United Kingdom**
Offers £5,000 max or 25% of retail. Plans to have more than 1,000 electric vehicles for its fleet and 25,000 charging points by 2015 to support running of a target 100,000 electric vehicles.

**France**
Offers €5000 or 20% of retail, valid up to 2012. Offers up to 1,000 charging stations. €400 million budget allocated for incentives, technology, and infrastructure.

**Germany**
€3,000 to 5,000 for the first 100,000 vehicles. €500 million budget allocated for EV incentives, technology, and infrastructure.

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**Asia**

**China**
Offers up to USD $8,800 in subsidies. Plans to invest USD $15 billion to help domestic automakers put 20 million fuel-efficient vehicles on China’s roads by 2020.

**India**
Offers $2,200 or 20% of retail for electric vehicles, plus other smaller subsidies for electric 2-wheelers which is majority of the market.

**Japan**
Enforces periodic vehicle inspection, testing, and taxation based on engine size to drive adoption. By 2020, 1 in 5 will be an EV vehicle. ¥106 billion budget allocated.

Sources: Frost & Sullivan, J.D. Power Associates
Operational / Environmental Metrics

• On average the GE DuraStation decreases EV charging time from 12-18 hours to as little as 4-8 hours compared to standard charging, assuming a 24 kWh battery and a full-cycle charge.

• If 10,000 vehicle owners switched from gas-powered passenger cars to EVs, over 33,000 metric tons of CO2 emissions could be avoided annually.

• This is equivalent to the annual CO2 emissions of approximately 6,500 gas-powered passenger cars on U.S. roads.

• On average, an EV owner will save about 75% of the annual fuel costs by switching from gas to electric

Assumptions: EVs have a typical 24 kWh battery with 100 mile range, vehicles travel a typical 12,000 miles per year, and the EVs are powered by the average US electricity grid mix.
EV-Related LEED Status Points

**LEED-NC: Sustainable Sites Credit 4.3**

3 points available if 5% of parking is made available for low-emission & fuel efficient vehicles

**LEED-EB: Sustainable Site Credit 4.0**

3 to 15 points available for the reduction in conventional commuting trips from 10-75%

For more information on LEED, please visit [www.geelectrical.com/energy](http://www.geelectrical.com/energy)
Electric Vehicle Supply Equipment (EVSE) Infrastructure
<table>
<thead>
<tr>
<th></th>
<th>Petrol (ICE)</th>
<th>Hybrid (HEV)</th>
<th>Plugin Hybrid (PHEV)</th>
<th>100% Battery (EV, GEV, BEV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range:</td>
<td>440 miles</td>
<td>440 miles</td>
<td>440 miles</td>
<td>100 miles</td>
</tr>
<tr>
<td>Refuel Time:</td>
<td>5 min</td>
<td>5 min</td>
<td>&lt;1h Level 2 Charge</td>
<td>4–8h Level 2 Charge</td>
</tr>
<tr>
<td>Usage:</td>
<td>1st car Family car</td>
<td>1st car</td>
<td>1st car Family car</td>
<td>2nd car City car</td>
</tr>
<tr>
<td>Energy Efficiency:</td>
<td>Not Efficient</td>
<td>Efficient</td>
<td>More Efficient</td>
<td>Most Efficient</td>
</tr>
<tr>
<td>Customer Mind:</td>
<td>Benchmark + Electric motor + Charging + 100% Battery</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PHEV:** Plug-in Hybrid Electric Vehicle
**REEV:** Range Extended Electric Vehicle
**BEV:** Battery Electric Vehicle
**EV:** Electric Vehicle
Overview

**EVSE** electric vehicle supply equipment

**EV** electric vehicle

- AC Power Supply
- Protections
- AC Power Supply
- Inverter
- On board charger
- Motor
- Battery

**Pilot**
- AC charging plug
- AC charging cable
## Charging Options – Why use Level 2?

<table>
<thead>
<tr>
<th></th>
<th>Level 1 Charging</th>
<th>Level 2 Charging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Source</strong></td>
<td>110 VAC, 15 A (16A peak), Household Wall Outlet</td>
<td>208 – 240 VAC, 30 A, Dual Pole Dedicated Circuit</td>
</tr>
<tr>
<td><strong>Max Charging Power Output</strong></td>
<td>Up to 1.65 KW</td>
<td>Up to 7.2 KW (240V @ 30A)</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>12 – 18 hours</td>
<td>4 – 8 hours</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>Plug-in wall outlet connector</td>
<td>Electrician Installation Needed</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>Household Circuit Breaker, UL, Ground Fault, Cable only energized when charging</td>
<td>Household Circuit Breaker, UL, Ground Fault, Cable only energized when charging</td>
</tr>
<tr>
<td><strong>Accessibility</strong></td>
<td>Accessible everywhere</td>
<td>Dedicated equipment and cable</td>
</tr>
<tr>
<td><strong>Procurement</strong></td>
<td>Typically included w/car</td>
<td>After-Market Purchase</td>
</tr>
</tbody>
</table>
GE Hardware Lineage

Charging Station
• POS Interface (Credit Card Swipe)
• Smart Metering
• Flex Charging
• Wireless Communications

Watt Station Residential
• Home Use
• Low Cost
• Lightweight Plastic

Watt Station
• Touch Screen Monitor
• Ergonomic Design
• Curb Appeal
• Retractable Cord Management
GE EV Charging Station presents a highly modular design that can be upgraded as new technology arrives and customer needs evolve.

Various Form Factors - Single/Double Pedestal, Wall, Pole
GE EV Charging Station Specification

- Supply Needs: 208-240VAC @ 30A with 40A overload (2 pole)
- GF Protection with Ground Monitor (UL 2231)
- Charger & Vehicle Communication (NEC 625)
  - Connection Interlock
  - Personnel Protection
  - Automatic De-Energizing Device
  - Ventilation Interlock
- Connection for SAE J1772 Plug & Cord
- LED Lights & Display
- RFID User Authorization Option
- Indoor & Outdoor Enclosure (NEMA 3R)
RFID Reader Option

Optional Radio Frequency Identification (RFID) to control user access

Details:
• Wave card in front of reader to initiate charging
• Monitor/Control of Driver Access/Usage
• Ethernet network to support RFID authorization service
• Straightforward In Field Installation

Administration – Programming Cards
• USB connected RFID programmer
• Lightweight and Portable
• Determines class authorization, user control
US Compliance and Standards

U.S. Electric Vehicle Standards

- UL 2594, for EVSE
- UL 2231, the Standard for Safety of Personnel Protection Systems for EV Supply Circuits
- NEC Article 625, Electric Vehicle Charging System
- SAE (Society of Automotive Engineers) J1772, Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler

GE’s UL Expertise

- Certified UL lab facilities for witnessing and testing at Industrial Solutions HQ in Plainville, CT
- UL lab capabilities include: handling overload, endurance and short circuit, EMI testing, material and environmental analysis
- GE Industrial Solutions has over 3,000 unique catalog numbers that are UL listed
- UL collaborates with GE for industry guidance in technology and safety, and managing policy and technical content
WattStation Home

Exterior

- **Power Button**
  OFF/standby button

- **LED interface and Ring**
  Visualization of station status

- **Charging Cable**
  Socket with interlock
  SAE J1772

- **Weatherized Case**
  Molded Lightweight Plastic
  Keylock security
  Nema 3R / IP54

- **Plug-In Option**
  SKU with plug option for easy install / removal
WattStation Home

Features

• Level II – 208-240 VAC, 30 A
• Indoor / Outdoor (NEMA-3R)
• Flush Mounting System
• Safety Protections
  • Ground Fault
  • Overload
• Vehicle Communications
  • SAE J1772 Connector
• UL Certified
• Power Off / Standby Switch
• LED Status Indicators
• Wrap Around Cord Management
Introducing the GE WattStation™

An easy-to-use charger designed by renowned industrial designer Yves Behar

“The GE WattStation achieves this with a welcoming design that is seamlessly integrated in the urban landscape and becomes a natural part of our daily driving routine.”

“Good design is when a new technology enters our life and makes it simpler, beautiful and healthy”
GE WattStation™ … a closer look

GE WattStation provides a **modular design** to integrate new technology

- Interactive Display Panel
- LED Ring Charger Status
- Card Swipe (optional)
- Protected Plug Holder
- Access Panel (on rear)
- Retractable Power Cord
- Base to accept power and fasten to concrete
GE WattStation™ Internal Components

Supply Needs: 16A@230V to 32A@400V

**Controller**
- EV Communications
- Charger status/messages via LED Ring, Interactive Display Panel, or external comms
- Manages Intelligent charging (Flex Charging)
- Allows user configurable overload protection
- Performs CCID20 ground fault protection per UL 2231
- Provides single phase metering
- Communications to Building Management Systems (BMS), EV, smart meters

**Contactor**
- Responsible for energizing and de-energizing of EVSE connector,
  Operates in conjunction with controller to meet UL and NEC reqs

**Connector**
- Compliant with SAE J1772 standard
- UL listed for EVSE applications

**Fuses**
- Provides overload and short circuit protection

**Options:**
- Wireless Communications
- Point of Sale (Credit Card)
- RFID, Smart Metering
Charging Station Communications

Kiosk / LED Wireless
- WiFi, GPRS, Zigbee
- Ethernet

BackEnd
(Database, Web Services)

Owner

Utility

Building (BMS) /
Home (HEM)

EV
SAE J1772, Wireless
(future)

Driver

Services
- Email
- SMS
- eWallet
- Web

Commerc

al Interests
GE Meets Your EV Needs

**Customer EV Need**

Future Proof EV Equipment

Assistance with Upstream ED Infrastructure

Support, Service, Experience

**GE Solution**

✔ GE’s EVSE Product Line is future proof with modular hardware and remote firmware upgrades

✔ GE has the industry expertise and support to help you build a robust EV system and meet all standards

✔ GE provides installation services with ServiceMagic network of installers, provides exceptional customer support and has over a century of experience in power engineering. GE is a brand you can rely upon.

GE imagination at work
GE Is Uniquely Positioned . . .

**Power Sources**
Electric vehicles will be powered by energy from traditional and renewable sources like solar, wind.

**Smart Grid**
A smarter grid will transmit information between utilities and charging stations, helping to create additional capacity, and enabling consumers to manage vehicle charging costs.

**Infrastructure**
GE provides infrastructure solutions like transformers, substations, and load centers, that support the roll-out of electric vehicles.

**Commercial Charging Stations**
Charging Stations will be available on city streets, retail destinations and other parking facilities.

**Home Charging Stations**
While you can plug an EV into any standard household 120V outlet, you’ll get a significantly faster charge and optional internet connectivity if you install a charger like GE’s WattStation.

**Lightweight Materials**
Automotive design has made EVs more powerful and efficient than ever.

**Better Batteries**
Enable longer ranges with decreased charging times.

**Recuded Emissions**
EVs can reduce CO2 emissions over 30% given the current US grid mix.

**Financing Solutions**
GE Capital will provide solutions for businesses to finance electric vehicles for their fleets.

**Up to 100 Miles On A Full Charge**
A full charge with a level 2 charger like GE’s WattStation takes 4–8 hours and can take a car for up to 100 miles.
Thank You …

Questions?