EV Technology Videos – YouTube Links

Toyota Hybrid – How It Works
http://www.youtube.com/watch?v=4CFxQGWAaho

Chevy Electric and Extended Range – How It Works
http://www.youtube.com/watch?v=AX5ZwzNwTo4&feature=related

GE EV Solar Carport EV Charging Station Construction
http://www.youtube.com/watch?v=rPn2pmhvpPo
Pre-Seminar EV Technology Videos

Formula 1 – KERS (Kinetic Energy Recovery System) Example = Red Bull Racing Team
http://www.youtube.com/watch?v=VYqhApWgZ74

24 Hours of LeMans – Hybrid Example = Toyota TS030
http://www.youtube.com/watch?feature=endscreen&NR=1&v=0bFSHzv4wkJ
Basics of Electric Vehicle Charging Stations

Electric cars are here. This introductory course focuses on the charging stations used to recharge these vehicles.

Beginning with the various types of vehicles, continuing to the three levels of charging setups then detailing exterior/interior functional components and concluding with infrastructure examples.

This session will provide insight into how this technology will shape our future in transportation.
General Electric

Basics of Electric Vehicle Charging Stations

8:00pm – 9:00pm
Cocoa Terrace

Dennis Balickie – GE Specification Engineer
Growth Factors and Key Influencers
Project Get Ready: Electric Vehicles in America
3 Key Drivers for EV Growth

1. Government Funding and Incentives

2. Auto Manufacturer EV Pipeline

3. Shifting Consumer Mindset
Government Funding and Support

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
   - **Commercial Infrastructure:** Tax credit for 30% of the cost of charging station installation, up to $30,000
   - **Consumer Infrastructure:** Tax credit of 30% of the cost of charging station installation, up to $1,000.
   - Applies to all equipment installed by the end of 2011

4. **Additional EV Infrastructure Incentives in States (CA, MD, WV, DC, HI)**
   - Handfull of municipalities also offering incentives
   - Some Utility Rate Reductions in place
   - Check with your state and city government agencies for details
Automobile Investment & Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Sport/Luxury</th>
<th>Compact</th>
<th>Sedan/SUV</th>
<th>Light Trucks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Tesla Roadster</td>
<td>Mini EV</td>
<td>GM Volt</td>
<td>Smith Electric Edison</td>
</tr>
<tr>
<td>2010</td>
<td>Tesla Model S</td>
<td>Wheego LiFe</td>
<td>Nissan Leaf</td>
<td>Navistar eStar</td>
</tr>
<tr>
<td>2011</td>
<td>Audi A1 PHEV</td>
<td>Mitsubishi i-MiEV</td>
<td>Coda EV</td>
<td>Ford Transit Connect</td>
</tr>
<tr>
<td>2012</td>
<td>Fisker Karma</td>
<td>Smart for two</td>
<td>Toyota Prius PHEV</td>
<td>Mercedes Vito E-cell</td>
</tr>
<tr>
<td></td>
<td>Volvo V70 PHEV</td>
<td>Think City</td>
<td>Honda insight PHEV</td>
<td>Renault Kangoo</td>
</tr>
</tbody>
</table>

- PHEV: Plug-in Hybrid Electric Vehicle
- EV: Electric Vehicle
## Auto Manufacturer Activity

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

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

Hybrid & EVs as a Tangible Symbol

Desire for Fuel Efficiency

Expression of Personal Politics

New group of conscientious consumers is emerging

Environmentally Conscious
37%

Technology and Car Driven
37%

Frugal Travelers
26%
Terminology, Standards and LEED Points
Electric Vehicle Terminology

Hybrid or Standard Hybrid:
A vehicle with a gasoline engine and an electric motor, each of which can propel it. Traditionally the gasoline engine is the primary propelling component and the electric motor serves as an assisting/supplementary propelling component.

Gasoline is the only fuel. Not really an Electric Vehicle. Doesn't require a charging station.

Video: http://www.youtube.com/watch?v=4CFxQ3WFAaho
Electric Vehicle Terminology

**EV:**
Electric Vehicles – The generic name for PHEV & BEV & REEV. EVs are equipped with charging ports to recharge the battery packs.

**Range Anxiety:**
Fear of running out of charge.

*Similar to now when you are on a long trip in your gasoline powered vehicle and you see the “Last Fuel Stop for XX Miles” sign and you start doing the mental MPG math.*
Electric Vehicle Terminology

Plug-in Hybrid (PHEV): A vehicle that has a battery bank that can be re-charged by plugging in to normal household current as well as using the on-board charging capabilities of normal hybrids.
Electric Vehicle Terminology

Battery Electric Vehicle (BEV):
A vehicle that uses chemical energy stored in rechargeable battery packs. BEV’s use electric motors and motor controllers instead of internal combustion engines for propulsion.
Electric Vehicle Terminology

Range Extended Electric Vehicle (REEV):
A vehicle that uses chemical energy stored in rechargeable battery packs. REEV's use electric motors and motor controllers instead of internal combustion engines for propulsion. A gasoline engine powers an electric generator to recharge the batteries and provide electric power directly.

http://www.youtube.com/watch?v=AX5ZweNwT04&feature=related
## Comparison of Vehicles

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Range:</td>
<td>400 miles</td>
<td>400 miles</td>
<td>400 miles</td>
<td>100 E-miles (300 RE-miles)</td>
<td>40 E-miles (300 RE-miles)</td>
</tr>
<tr>
<td>Refuel Time:</td>
<td>5 min</td>
<td>5 min</td>
<td>&lt;1 hr Level 2 Charge</td>
<td>4 – 8 hrs Level 2 Charge</td>
<td>4 – 8 hrs Level 2 Charge (5 min)</td>
</tr>
<tr>
<td>Usage:</td>
<td>1st car Family car</td>
<td>1st car Family car</td>
<td>1st car Family car</td>
<td>2nd car City car</td>
<td>1st car Family car</td>
</tr>
<tr>
<td>Energy Efficiency:</td>
<td>Not Efficient</td>
<td>Efficient</td>
<td>More Efficient</td>
<td>Most Efficient</td>
<td>Most Efficient with Range</td>
</tr>
<tr>
<td>Customer Mind:</td>
<td>Benchmark</td>
<td>+ Electric motor</td>
<td>+ Charging</td>
<td>+ 100% Battery</td>
<td>+ Generator</td>
</tr>
<tr>
<td>1st Year USA:</td>
<td>Early 1900’s</td>
<td>2001</td>
<td>2012</td>
<td>2010</td>
<td>2010</td>
</tr>
</tbody>
</table>
Electric Vehicle Terminology

**EVSE:**
Electric Vehicle Supply Equipment or charging station

**Level 1 (Slow Charging or “The Overnight Charge”)**
- 120VAC, 15A, compatible with the most commonly available grounded electrical outlet (Usually provided with the car)
- Typical charge time: 8 - 10+ hours

**Level 2 (Faster Charging or “At the Office Charge”)**
- 208-240VAC, up to 80A (Standard Current is 30A)
- Typical charge time: 4 - 8 hours

**Level 3 (DC Charging)**
- Typical charge time: 15 - 30 minutes

Note: actual charge time depends on a number of factors
## 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>8 – 10+ 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>
Level 3 Charging Station Overview

Current Status of Level 3 Charging

- Only Nissan, Mitsubishi, and smaller OEMs have a Level 3 Port
  - Chevy and Ford can NOT be charged via DC fast charger.
  - Society of Automotive Engineers has not standardized on a plug
    - You will probably not see American car companies adopt level 3 charging until SAE develops the Level 3 plug (~late 2012).

Excerpt from Nissan Manual on L3 Charging

A vehicle equipped with a quick charge port is compatible with most CHAdeMO (Japanese industry standard) connectors on charging stations. Charging stations using this standard are UL certified and safe to use in the US. While supported by NISSAN, this connector may not become the US SAE standard. NISSAN recommends that quick charging not be performed more than once a day.
# Cost of charging an EV

**BEV battery capacity**
- Nissan LEAF: 24kWh
- GM Volt: 16kWh
- CODA sedan: 34kWh
- Tesla model S: 56kWh

## Level 1 ... 120Vac, 15A

<table>
<thead>
<tr>
<th>Charge time (hrs)</th>
<th>Total kWh</th>
<th>% of capacity (LEAF)</th>
<th>Retail electricity cost*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.9</td>
<td>12%</td>
<td>$0.35</td>
</tr>
<tr>
<td>2</td>
<td>5.8</td>
<td>24%</td>
<td>$0.69</td>
</tr>
<tr>
<td>3</td>
<td>8.6</td>
<td>36%</td>
<td>$1.04</td>
</tr>
<tr>
<td>4</td>
<td>11.5</td>
<td>48%</td>
<td>$1.38</td>
</tr>
<tr>
<td>5</td>
<td>14.4</td>
<td>60%</td>
<td>$1.73</td>
</tr>
<tr>
<td>6</td>
<td>17.3</td>
<td>72%</td>
<td>$2.07</td>
</tr>
<tr>
<td>7</td>
<td>20.2</td>
<td>84%</td>
<td>$2.42</td>
</tr>
<tr>
<td>8</td>
<td>23.0</td>
<td>96%</td>
<td>$2.76</td>
</tr>
<tr>
<td>9</td>
<td>25.9</td>
<td>100%</td>
<td><strong>$3.11</strong></td>
</tr>
</tbody>
</table>

## Level 2 ... 240Vac, 30A

<table>
<thead>
<tr>
<th>Charge time (hrs)</th>
<th>Total kWh</th>
<th>% of capacity (LEAF)</th>
<th>Retail electricity cost*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.6</td>
<td>28%</td>
<td>$0.80</td>
</tr>
<tr>
<td>2</td>
<td>13.3</td>
<td>55%</td>
<td><strong>$1.60</strong></td>
</tr>
<tr>
<td>3</td>
<td>20.0</td>
<td>83%</td>
<td><strong>$2.40</strong></td>
</tr>
<tr>
<td>4</td>
<td>26.6</td>
<td>100%</td>
<td><strong>$3.19</strong></td>
</tr>
</tbody>
</table>

* at avg retail rate of $0.12kWh

$3.00 per charge equates to
- 100 miles for BEV (max)
- 40 miles for REEV (max)

Retail electricity cost is ~$3 per full charge
U.S. Electric Vehicle Standards

**UL 2594, for EVSE**

UL 2594 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 onboard charging unit. The products covered by UL 2594 include EV Power Outlets, EV cord sets and EV charging stations, Level 1 & 2.

**UL 2231, the Standard for Safety of Personnel Protection Systems for EV Supply Circuits**

This Standard covers devices and systems intended for use in accordance with the National Electrical Code® (American National Standards Institute/National Fire Protection Association 70), to reduce the risk of electric shock to the user from accessible parts, in grounded or isolated circuits for charging EVs.

**NEC Article 625, Electric Vehicle Charging System**

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.

**SAE (Society of Automotive Engineers) J1772, Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler**

This SAE Recommended Practice covers the general physical, electrical, functional and performance requirements to facilitate conductive charging of EV/PHEV vehicles in North America. This document defines a common EV/PHEV and supply equipment vehicle conductive charging method including operational requirements and the functional and dimensional requirements for the vehicle inlet and mating connector.
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)
Level 2
Charging Station Details and Power Requirements
Overview

EVSE: electric vehicle supply equipment

Power

Pilot

AC charging plug

AC charging cable

EV: electric vehicle

Protections

AC Power Supply

Inverter

On board charger

Battery

Motor
Interior System Components

- **Controller**
  - Smart features for control, communication and safety
- **Ground Fault CT**
  - Protection against Ground Fault
- **Current Transformer**
  - One phase metering / Overload
- **NEMA Contactor**
  - Energize or de-energize
- **Fuse**
  - Overload and short circuit protection
- **LED Light Bar**
- **VFD Vacuum Fluorescent Display**
- **Control Lines**
  - Control and Communications Signals within EVSE
- **Cable & SAE J1772 Connector**
  - Attaches to Electric Vehicle

**AC Power**
- 208-240 VAC / 30 Amps
# Protection

<table>
<thead>
<tr>
<th>Protection Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overload and short circuit protection</td>
<td><strong>Level 2 Electric Vehicle Supply Equipment (EVSE)</strong></td>
</tr>
<tr>
<td>Primary</td>
<td>Dedicated 40A Circuit Breaker in the Distribution Panel</td>
</tr>
<tr>
<td>Secondary</td>
<td>Controller and current transformer Inside EVSE</td>
</tr>
<tr>
<td>Personel protection</td>
<td><strong>CCID20</strong> 15-20 mA Ground Fault Protection</td>
</tr>
<tr>
<td></td>
<td><strong>SAE J1772</strong> Pilot function de-energizes connector when not attached to vehicle</td>
</tr>
<tr>
<td>Energize/De-energize</td>
<td><strong>Contactor</strong> 2-pole 90 A Auxiliary Contact</td>
</tr>
<tr>
<td></td>
<td><strong>Proximity</strong> Proximity function controls presence of EV</td>
</tr>
</tbody>
</table>
Connection

Power
Single Phase Metering, Standby Power 5W Typical
Random start up between 0 and 15 minutes to avoid overload

Interface
Standard interface across North America
Level 2 Charging -> 208-240 VAC, up to 30A logical requirements (up to 80 A possible)
Control & Pilot Function

Socket
SAE J1772 Connector – Standard Across North America
• L1 & L2 – Hot Voltage for two pole circuit
• CP – Control Pilot Signal – provides communication between vehicle and charger to coordinate charging
• PD – Proximity Detector - Allows vehicle to determine if EVSE is connected
• GND – Ground / Common

J1772 Socket Pin-Out
Connection

Pilot function

- EV connected
- EV determines available current
- EV ready to charge
- EVSE energizes
- EVSE alters available current
- EV stops charging
- EV disconnected

Pilot

Power

+ 9V
Typical Commercial EVSE Unit

- **LED Bar Charger Status**
- **VFD Screen**
- **RFID (optional)**
- **Plug Holder**
- **Power Cord Holder**
- **Access Panel (right side)**

**LED Bar Charger Status**
- GREEN = Ready
- GREEN-BLINKING = Connected
- YELLOW = Charging
- RED = Error / Not Authenticated

**VFD Screen**
- Operations Instructions
- Status Details

**RFID (optional)**
- Controlled Access / Usage

**Plug Holder**

**Power Cord Holder**

**Access Panel (right side)**
## Typical Mounting Configurations

<table>
<thead>
<tr>
<th></th>
<th>Wall mount</th>
<th>Pole mount</th>
<th>Single Pedestal</th>
<th>Double Pedestal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. Connectors</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Dimensions (in)</strong></td>
<td>31.52&quot;H x 11.82&quot;W x 11.16&quot;D</td>
<td>31.52&quot;H x 11.82&quot;W x 11.16&quot;D</td>
<td>51.1&quot;H x 14.9&quot;W x 13.8&quot;D</td>
<td>51.1&quot;H x 14.9&quot;W x 13.8&quot;D</td>
</tr>
<tr>
<td><strong>Weight (lbs)</strong></td>
<td>75</td>
<td>75</td>
<td>140</td>
<td>175</td>
</tr>
<tr>
<td><strong>Form Factor</strong></td>
<td><img src="image1.png" alt="Wall mount" /></td>
<td><img src="image2.png" alt="Pole mount" /></td>
<td><img src="image3.png" alt="Single Pedestal" /></td>
<td><img src="image4.png" alt="Double Pedestal" /></td>
</tr>
<tr>
<td><strong>Outdoor rated</strong></td>
<td>NEMA – 3R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Material</strong></td>
<td>Hot rolled, low carbon steel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Typical Commercial EVSE Specifications

- 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 Plug & Cord (SAE J1772)
- LED Lights & Display
- Indoor & Outdoor Enclosure (NEMA 3R)
- RFID User Authorization (Optional)
- Network Communications (Optional) – Ethernet CAT5, RS232
Typical Light Commercial EVSE Unit
Level 2 Unit
Residential EVSE Unit - Wall Mount Only

Charging Icon
GREEN = Charging

Fault Icon
RED = Error / Fault

Power Button
OFF / Standby Button

LED Ring Charger Status
Visualization of station status
WHITE = Ready / Standby Mode

Weatherized Case
Molded Lightweight Plastic
Nema 3R / IP54

Charging Cable
Socket with interlock
SAE J1772

Power Cord Plug-In Option
Plug option for easy install / removal
Typical Light Commercial EVSE Specifications (Level 2)

- Supply Needs: 208-240VAC @ 30A with 40A overload (2 pole)
- GF Protection with Ground Monitor (UL 2231)
- Safety Protections
  - Ground Fault
  - Overload
- Connection for Plug & Cord (SAE J1772)
- Meets UL Standards Compliance
- Wrap Around Cord Management
- 2 piece mounting bracket for easy installation
- Lockable mounting brackets to prevent theft
- Indoor & Outdoor Enclosure (NEMA 3R)
Connections and Infrastructure Examples
Typical EV Infrastructure

Utility Supply → Utility Transformer → Switchgear → Switchboards And Panelboards

Power Panel Sub-metering → General Purpose Transformers → Ltg/Appl Panels Load Centers → EV Charging Stations
Electrical Example – Individual Unit

Home – 1 EVSE unit – Wall mount

- Single EVSE 30A Total
- #8 AWG Cu THWN Conduit
- 2 pole 40A 120/240 Breaker
- Utility Meter
- Domestic Service Line
Electrical Example – Small Installation

Retail / Commercial / Office – 3 Pedestal EVSE units

Ensure that capacity of panel board and service are not exceeded. Select conductor size according to the NEC.
Electrical Example – Larger Installation

Car Group – Hotels, Parking Garage, etc – 12 Pedestal EVSE units

Twelve EVSE 360A Total

400AF/400AT MCB Panel

#8 AWG Cu THWN Conduit

Twelve 2-pole 40A 120/240V Breakers

From Power Panel Board Switchboard MCC Switchgear

175AT/250AF Breaker

112.5kVA Dry Transformer

2 – 250 AL kcmil THWN

Ensure that capacity of panel board and service are not exceeded. Select conductor size according to the NEC.
Present and Future Technologies
Where are we today?

**Global unit sales**

- **Electric Vehicles**
- **Charging Stations**

<table>
<thead>
<tr>
<th>Year</th>
<th>Units in thousands</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>400</td>
</tr>
<tr>
<td>2011</td>
<td>800</td>
</tr>
<tr>
<td>2012</td>
<td>1,200</td>
</tr>
<tr>
<td>2013</td>
<td>1,600</td>
</tr>
<tr>
<td>2014</td>
<td>2,000</td>
</tr>
<tr>
<td>2015</td>
<td>2,400</td>
</tr>
</tbody>
</table>

Source: Pike Report

**Battery cost/kwh curve**

- **High cost**
- **Medium cost**
- **Low cost**

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost (kwh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>2,000</td>
</tr>
<tr>
<td>2010</td>
<td>1,488</td>
</tr>
<tr>
<td>2015</td>
<td>1,150</td>
</tr>
<tr>
<td>2020</td>
<td>735</td>
</tr>
<tr>
<td>2025</td>
<td>550</td>
</tr>
<tr>
<td>2030</td>
<td>335</td>
</tr>
</tbody>
</table>

Source: McKinsey.

**EV Production Start**

- **1st USA mainstream sales in late 2010**...
- Before that the industry was a specialty market

**California Estimates**

- **250,000 to 275,000 PEVs** by 2015

**Big disruptive market**

- **Total EV cost** of ownership improves as battery costs decrease
- Most manufacturers launching in 2011...
- **3-5% of global production** by 2015
- **Typical early market issues** – complexity, confusion, dynamic environment
EV Ecosystem Community Deployment

- Hotel: 15-20 Chargers
- Office Parking: 3-5 Chargers
- Shopping Mall: 10-20 Chargers
- Public Parking: 15-25 Chargers
- For the Home: 1 Charger
Worse Case Driving Distance - 12 mile Radius

Either Winter with Heater On OR Summer with AC On

BEV
- Here & Back

REEV
- Here & Back
Worse Case Driving Distance - 25 mile Radius

Either Winter with Heater On OR Summer with AC On

BEV
- Here & Back

REEV
- Here ONLY
- Gas Generator for Return OR Recharge at the Lodge
Worse Case Driving Distance - 50 mile Radius

Either Winter with Heater On OR Summer with AC On

BEV
- Here Only
- Recharge at the Lodge

REEV
- Here on Battery Power 1st then on Gas Generator 2nd
New Business Opportunities

On Site Services via EVSE Interface
- Advertisements and Commerce Options
- Reservations for other services
- Information on local events, advisories

Mobile Phone Services for Consumers
- Real-Time Charging Status/Updates
- Promotions
- Social Networking
Sample App Screens

Login Screen

Application Selection Screen

Search for available charging stations by provider, address, service group, etc.

Admin view of Station utilization and flex charging reporting

Detailed view of station performance, revenues, etc.

Flex Charging configuration and reporting
Differentiate to Attract Business and Individuals
as a Free Service / Pass-Thru Service / Revenue Service

- Corporate Citizenship
- Meet Present Employee Needs
- Attract New and Retain Existing Employees
There will be a time in the future when Electric Vehicles will be as common as Hybrid Vehicles are now. And so will the charging stations that support them.

Hybrid Auto Technology is only 10 years old in the US.

Seeing a Prius on the road is commonplace now.
Next Generation EVSE Unit
Modular Design to integrate new technology

Options:
- Wireless Communications
- Point of Sale (Credit Card kiosk)
- RFID, Smart Metering
Solar Carport EV Charging Stations

http://www.youtube.com/watch?v=rPn2pmhypRc
Thank You for Your Time

Q & A
Summary of the Nissan's results using EPA L4 test cycle operating the Leaf under different real-world scenarios\textsuperscript{[67][68]}

<table>
<thead>
<tr>
<th>Driving condition</th>
<th>Speed</th>
<th>Temperature</th>
<th>Total Drive Duration</th>
<th>Range</th>
<th>Air conditioner</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mph</td>
<td>km/h</td>
<td>°F</td>
<td>°C</td>
<td>mi</td>
</tr>
<tr>
<td>Cruising (ideal condition)</td>
<td>38</td>
<td>61</td>
<td>68</td>
<td>20</td>
<td>3 hr 38 min</td>
</tr>
<tr>
<td>City traffic</td>
<td>24</td>
<td>39</td>
<td>77</td>
<td>25</td>
<td>4 hr 23 min</td>
</tr>
<tr>
<td>Highway</td>
<td>55</td>
<td>89</td>
<td>95</td>
<td>35</td>
<td>1 hr 16 min</td>
</tr>
<tr>
<td>Winter, stop-and-go traffic</td>
<td>15</td>
<td>24</td>
<td>14</td>
<td>-10</td>
<td>4 hr 08 min</td>
</tr>
<tr>
<td>Heavy stop-and-go traffic</td>
<td>6</td>
<td>10</td>
<td>86</td>
<td>30</td>
<td>7 hr 50 min</td>
</tr>
<tr>
<td>EPA five-cycle tests\textsuperscript{[8]}</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>73</td>
</tr>
<tr>
<td>Reviewer</td>
<td>Driving condition</td>
<td>All-electric range</td>
<td>Fuel economy EV mode (MPG-e)</td>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------------------------------------------------------------------------</td>
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<td>------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>EPA 2011 model year</td>
<td>EPA five-cycle tests: varying driving conditions and climate controls</td>
<td>35 mi (56 km)</td>
<td>37 mpg-e (6.4 L/100 km)</td>
<td>All ratings combined city and highway Overall combined gasoline-electric fuel economy rating of 66 mpg-e (3.9 L/100 km; 72 mpg-e) equivalent (MPG-e)</td>
<td></td>
</tr>
<tr>
<td>EPA 2012 model year</td>
<td>EPA five-cycle tests: varying driving conditions and climate controls</td>
<td>35 mi (56 km)</td>
<td>39 mpg-e (6.5 L/100 km)</td>
<td>All ratings combined city and highway EV mode city 95 mpg-e (2.5 L/100 km) equivalent EV mode highway 93 mpg-e (2.5 L/100 km) equivalent Energy consumption of 36 kWh per 100 miles.</td>
<td></td>
</tr>
<tr>
<td>Consumer Reports</td>
<td>Long term test[^28]</td>
<td>35 mi (56 km)</td>
<td>32 mpg-e (7.4 L/100 km)</td>
<td>Several driving conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal daily commute under cold winter time[^29]</td>
<td>25 mi (40 km)</td>
<td>30 mpg-e (7.8 L/100 km)</td>
<td>Outdoor temperatures averaged about 20 to 30 °F (-7 to -1 °C). Almost 1,000 miles (1,600 km). Average combined 53 miles per US gallon (4.4 L/100 km)</td>
<td></td>
</tr>
<tr>
<td>Motor Trend</td>
<td>Long term test[^21]</td>
<td>Over 35 mi (56 km)</td>
<td>n.a</td>
<td>Normal everyday driving over 16,503 miles (26,559 km) during 8 months. Average combined fuel economy 48.9 mpg-e (4.81 L/100 km) equivalent. Energy consumption 68.7 kWh/hr/100 mi.</td>
<td></td>
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<tr>
<td></td>
<td>Extended test on cold winter time (February-mid April)[^22]</td>
<td>22 to 30 mi (35 to 48 km[^23])</td>
<td>n.a</td>
<td>Over 3,090 miles (4,970 km). 2,259 city/831 highway. Combined gasoline/electricity average fuel economy of 49.26 miles per US gallon (4.775 L/100 km) equivalent. Average cost US$0.08/mi (US$0.05/km). Maximum EV range: 39.4 miles (63.4 km) at 50 °F (10 °C).[^22]</td>
<td></td>
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<tr>
<td>Edmunds.com[^25]</td>
<td>Typical traffic driving</td>
<td>33 mi (53 km)</td>
<td>31.4 mpg-e (7.49 L/100 km)</td>
<td>Over 1,000 km. Lowest range 27 mi (43 km) and highest 39 mi (63 km). Energy consumption 39.9 kilowatt-hours per 100 miles.</td>
<td></td>
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<tr>
<td>Car and Driver[^24]</td>
<td>City streets</td>
<td>n.a.</td>
<td>n.a</td>
<td>EV mode only using climate control. Downtown Ann Arbor, 43 mi (69 km) at an average speed of 15 mph (24 km/h).</td>
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</tr>
<tr>
<td></td>
<td>Suburban commute</td>
<td>n.a.</td>
<td>n.a</td>
<td>EV mode only using climate control, over 42 mi (68 km) at an average speed of 46 mph (74 km/h).</td>
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<td>Highway</td>
<td>n.a.</td>
<td>40 mpg-e (5.9 L/100 km)</td>
<td>Michigan Peninsula over 894 mi (1,439 km) at an average speed of 70 mph (110 km/h). Gasoline and electric using climate control.</td>
<td></td>
</tr>
<tr>
<td>Popular Mechanics[^25][^26]</td>
<td>Two-lane roads under “lead-foot” style driving, A/C off</td>
<td>31 mi (50 km)</td>
<td>n.a</td>
<td>n.a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>City streets under normal style driving, A/C on</td>
<td>35 mi (56 km)</td>
<td>31.7 mpg-e (7.42 L/100 km)</td>
<td>n.a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Highway only</td>
<td>33 mi (53 km)</td>
<td>36 mpg-e (6.5 L/100 km)</td>
<td>Over 600 miles (970 km) at an average speed of 78 mph (126 km/h).</td>
<td></td>
</tr>
</tbody>
</table>