“Plug-in Electric Vehicles are Coming... 
...is your Region Ready?”

Kristin Zimmerman, Ph.D.
General Motors: Advanced Technology Infrastructure – Chevy Volt Team
Electric Vehicle (with a Range-Extender) Chevrolet Volt

Launching in November 2010
Up to 40 miles BATTERY Electric Drive + HUNDREDS of miles EXTENDED RANGE Driving (Gasoline or E85)
Typical Commute

Why Target 40 Miles? → 40 Miles Is the Key

78% of customers commute 40 miles or less daily

Based on U.S. Department of Transportation 2003 Omnibus Household Survey
## Variations on Electric Vehicles

### Electric Vehicle with Extended-Range

<table>
<thead>
<tr>
<th>PHEV</th>
<th>EREV</th>
<th>Pure EV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plug-in Hybrid Electric Vehicle</strong></td>
<td><strong>“Extended-Range” Electric Vehicle</strong></td>
<td><strong>Pure Electric Vehicle</strong></td>
</tr>
<tr>
<td>• All-electric at low speed/power</td>
<td>• All-electric for up to 40 miles</td>
<td>• All-electric for ~100 miles</td>
</tr>
<tr>
<td>• Blended elect/gas at higher speed/power</td>
<td>• Gas generator for +300 miles (extended driving range)</td>
<td>• Fuel is electricity</td>
</tr>
<tr>
<td>• Primary fuel is gasoline supplemented with electricity (typical)</td>
<td>• Primary fuel is electricity supplemented with gasoline (Volt)</td>
<td>(typical)</td>
</tr>
</tbody>
</table>
Pre-Production Volt:
Engineering Test Drive – 13 Oct 2009
The first pre-production Chevrolet Volt moves along the assembly line at the Detroit-Hamtramck manufacturing plant -- March 29, 2010
GM/Utility Partners & Volt Retail Market Rollout

- Launch beginning in late 2010
- Nationwide deployment as quickly as feasible
- Initial launch markets announced: California, Michigan, Washington D.C.
- 3 ways Volts arrive in markets: Dealer Sales, Migrations, and a few Demonstrations
Charging and Infrastructure
Six Things We Need to Get Right

• Market analysis
• Technical features
• Customer experience
• Public education
• Public policy
• Advanced features and new opportunities
Plug In Readiness…

• The coordination of all funds, policies and programs either already available or proposed supporting EV infrastructure while leveraging ALL stakeholders in the plug in readiness value chain

• Opportunity to define and build new jobs, workforce training, new educational areas of expertise…a new, energy secure economy
Charging Power Levels

- **120V (1.2 kW) charging (15amp min, 20amp rec.):**
  - Plugs into standard household outlet
  - Full charge in about eight hours (temperature dependent)
  - No additional equipment or installation typically required
  - Charge cord standard with the vehicle in NA

- **240V (3.3 kW) charging (20amp min, 40amp rec.):**
  - Full charge in about three hours
  - Efficient and enables more opportunity to drive electrically
  - Will usually require a one-time investment to upgrade garage with dedicated 240V circuit

- **Charger and control logic onboard the vehicle**
Electric Grid Designed for Peak Demand
Volt Leverages Off-Peak for Charging

![Graph showing Electric Grid designed for peak demand with Volt leveraging off-peak for charging. The graph compares California ISO System Load for two dates: 29-Aug-07 and 1-Jan-07.](image-url)
Charging Infrastructure

- Public charging
  - High Visibility
  - Commercial/Retail
  - Public education and outreach

- Workplace
  - Corporate, Municipal Parking Lots

- Residential (majority)
  - Satisfying consumer-driven home installation process
  - Permits, electricians, inspections, meters, rates
Plug-in Ready Communities

Required Stakeholders

- Dedicated project leader
- State, city, county
- Clean Cities Orgs/AQMD
- DOT
- Utilities (municipal and regional)
- Regulators/public utility commissions
- Permitting and code officials
- Local employers
- Local universities

Desired Enablers

- Game Plan
  Infrastructure/Incentives/Educational Outreach
- Vehicle Purchase Incentives
- Charging Installation Incentives (Home, Work, Public)
- Low Off-Peak Charging Rates (e.g. to encourage nighttime charging)
- Green/Renewable Charging Options
- Building Codes to Include Home Charging Enablers
- Government Fleet Purchases
- HOV Lane Access
- Free Parking
- Free Charging
Secondary Battery Use – An Emerging Market

- Community Energy Storage (CES)
- Distribution Grid Management
- Renewable Energy Storage
V2G - G2V Communication Options

Non-AMI Communication Path
(Cellular Data as Transport Layer)

Customer/Utility Web Interface

Automated Meter Infrastructure
(HomePlug as Transport Layer)

GM’s 50 State Solution
Standards Compliant Communications

Vehicle ID
Connected/Not Connected
Connection Locations
Charge Start and End Times
Charge kWh
Charge Level kW

OnStar
by GM

Vehicle ID Verification
On/Off Cycle Message
TOU Rates

Off-Peak Charging and Demand Response Information
Gateway PLC-ZigBee
EVSE
HomePlug Transceiver

PHEV/EREV
Customer-Facing Applications for VOLT
Customer Benefits Delivered via OnStar, etc.
2¢ per mile

1/6

12¢ per mile
### How Does a Chevrolet Volt Compare?

#### Annual Energy Usage – Electrical Appliances

<table>
<thead>
<tr>
<th>Appliance</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Heating System</td>
<td>3,524</td>
</tr>
<tr>
<td>Central Air Conditioning</td>
<td>2,796</td>
</tr>
<tr>
<td>Refrigerator/Freezer</td>
<td>2,610</td>
</tr>
<tr>
<td>Water Heater</td>
<td>2,552</td>
</tr>
<tr>
<td><strong>Chevrolet Volt</strong></td>
<td>2,520</td>
</tr>
<tr>
<td>Clothes Dryer</td>
<td>1,079</td>
</tr>
<tr>
<td>Lighting</td>
<td>940</td>
</tr>
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Key Utility/Regulator “Asks”

Consumer Focus: Alleviate hurdles, successfully transition PEVs to early adopters

• **General Q&A**
  – Consumers - establish 1-800 number, brochure, website (w/ EDTA-NPVI site)
  – Consumers - simplified rate programs (encourage correct charging behaviors)
  – Infrastructure installers – establish 1-800 number

• **Residential Charging**
  – Utility involvement - first option for mitigating grid impacts
  – Ensure no/low impact (time, convenience, cost) of charging installation (incl. meter if needed, rate program signups)
  – Facilitate local fast-track permitting/inspection process

• **Rapid utility response** to any local grid issues
  – Anticipate impacts to local distribution systems

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• **Multi-family Residential/Workplace charging** – facilitate
• **Public Charging** - direct utility ownership of nominal backbone
• **EV and Infrastructure incentives** – support credits, waived fees,...
## Policy/Strategy to Achieve a Plug-in Ready Region

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<thead>
<tr>
<th>Required Stakeholders:</th>
<th>Required Enablers:</th>
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<tr>
<td><strong>Dedicated Project Leader</strong></td>
<td>Establish a public charging infrastructure plan; Establish a local/state incentives plan; Establish a marketing and educational outreach plan</td>
</tr>
<tr>
<td><strong>State Government</strong></td>
<td>Provide state tax credit for vehicles (&gt;$2,500/16kWh vehicle) and charging equipment and installation at home/multi-family home/workplace/public (up to $3,000/home; $30,000/other site with 10 charge ports); Eliminate state sales tax on vehicle purchase; Commit/fund government fleet purchases (200 vehicles)</td>
</tr>
<tr>
<td><strong>City/County Government</strong></td>
<td>Provide incentives for vehicle purchasers (see above - work with state) and charging equipment and installation (see above - work with state); Install public charging spots in key locations (30 distributed locations; meeting SAE J1772 level 2 (240V) and J2836 standards); refurbish existing charge sites; Establish free parking; Commit/fund government fleet purchases (25 high-profile vehicles)</td>
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<td><strong>Clean Cities Orgs / AQMD</strong></td>
<td>Provide incentives for vehicle purchasers (see above - work with state) and charging equipment and installation (see above - work with state); Install public charging spots in key locations (30 distributed locations; meeting SAE J1772 level 2 (240V) and J2836 standards); refurbish existing charge sites; Establish free parking; Commit/fund government fleet purchases (25 high-profile vehicles)</td>
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<tr>
<td><strong>DOT</strong></td>
<td>Provide HOV lane access for plug-in vehicles; Eliminate vehicle registration and license fees</td>
</tr>
<tr>
<td><strong>Permitting and Code Officials</strong></td>
<td>Prepare for eased/fast/self-permitting of home/public charging installation; Ensure new home/building codes/major renovations provide for vehicle 240V charging</td>
</tr>
<tr>
<td><strong>Utilities (municipal &amp; regional)</strong></td>
<td>Provide rebate for vehicle purchasers (add'l $2,500/16kWh vehicle); Provide and incentivize home/building charging installation electrical service (i.e. provide no/low cost installation financed thru monthly utility bill); Provide free charging or compelling low-cost EV rates (3-4 cents/kWh); Provide &quot;green&quot; electricity options; Commit/fund commercial fleet purchases (25 high-profile vehicles)</td>
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<td><strong>Regulators/Public Utility Commissions</strong></td>
<td>Provide rebate for vehicle purchasers (add'l $2,500/16kWh vehicle); Provide and incentivize home/building charging installation electrical service (i.e. provide no/low cost installation financed thru monthly utility bill); Provide free charging or compelling low-cost EV rates (3-4 cents/kWh); Provide &quot;green&quot; electricity options; Commit/fund commercial fleet purchases (25 high-profile vehicles)</td>
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<td><strong>Large Local Employers (as Early Adopters)</strong></td>
<td>Employers (3 major corporations) provide work-place charging (25 park/charge spots) and employee vehicle purchase incentives (add'l $2,500/vehicle); Commit/fund corporate fleet purchases (25 vehicles)</td>
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<td><strong>Local Universities</strong></td>
<td>Provide campus charging and free parking (10 distributed charging locations); Commit/fund university fleet purchases (5 high-profile vehicles)</td>
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• No Range Anxiety – No plug required
• Phased infrastructure rollout
• Streamlined purchase process – soup to nuts
• Coordination of all stakeholders, funds, programs
• An opportunity to define and build new jobs, markets...
• Catalyst for creating an energy secure economy