The World's Highest Volume EV

- Global sales: over 28,000
- Over 36 million miles driven globally

12,000 units 3,000 units 13,000 units

-- Winning more than 30 awards --
Global Investment (EV and Battery)

- Expand EV and Battery manufacturing globally

- Battery: Renault and Nissan
- EV: Nissan

Locations:
- France, Flin
- USA, Smyrna
- UK, Sunderland
- Japan, Oppama
- Japan, Zama

Map showing locations of battery and EV manufacturing facilities around the world.
Getting to Mass Market Volumes

Localize production at facilities to serve key global markets

- Smyrna, TN: production begins in 2012
- 200,000 battery capacity
- 150,000 vehicle capacity
## Nissan LEAF – Product Highlights

<table>
<thead>
<tr>
<th>Size</th>
<th>5-door mid size hatchback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>5 Adults</td>
</tr>
<tr>
<td>Range</td>
<td>100 miles (US LA4)</td>
</tr>
<tr>
<td>Top Speed</td>
<td>90 mph</td>
</tr>
<tr>
<td>Battery</td>
<td>Laminated Li-ion</td>
</tr>
<tr>
<td>Capacity/Power</td>
<td>24 kWh/over 90kW</td>
</tr>
<tr>
<td>Motor</td>
<td>High-response synchronous AC Motor (80kW/280Nm)</td>
</tr>
<tr>
<td>IT System</td>
<td>Integrated communication system</td>
</tr>
</tbody>
</table>
Pragmatists think differently from Early Adopters

- **Early Adopters**
  - Prioritizes environment and oil independence.
  - Willing to adopt new technology, pay a premium and be inconvenienced.
  - Prefers to purchase (perceived less wasteful).
  - Want Green options
  - Wants oil independence
  - Believes EV has lowest impact

- **Commonalities**

- **Pragmatists**
  - Unwilling to compromise low cost and high convenience.
  - Slow to adopt new technologies. Compares EV’s to ICE and HEV vehicles.
  - Prefers to lease (less risk)

“...I MAKE CHOICES THAT HELP THE WORLD...”

“...PARTICIPATE – AS LONG AS IT’S EASY, AFFORDABLE, AND CONVENIENT...”
LEAF Owners Driving Distance

LEAF Owners: Avg Daily Driving Distance

Nationally, daily driving distance is decreasing over time.

Travel Profile of the United States

Based on the latest data gathered from the Federal Highway Administration’s (FHWA) 2009 National Household Travel Survey (NHTS).

<table>
<thead>
<tr>
<th>Daily Travel Per Person</th>
<th>1995</th>
<th>2001</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person Trips</td>
<td>4.3</td>
<td>3.74</td>
<td>3.79</td>
</tr>
<tr>
<td>Person Miles</td>
<td>38.67</td>
<td>36.89</td>
<td>36.12</td>
</tr>
<tr>
<td>Vehicle Trips</td>
<td>3.57</td>
<td>3.35</td>
<td>3.02</td>
</tr>
<tr>
<td>Vehicle Miles</td>
<td>32.14</td>
<td>32.73</td>
<td>28.97</td>
</tr>
</tbody>
</table>

Oceanus Automotive © 2012.
# Charging Network

<table>
<thead>
<tr>
<th>EV Usage</th>
<th>Home Charging</th>
<th>Destination Charging</th>
<th>Pathway Charging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Distance</td>
<td>Normal</td>
<td>Mid Distance</td>
<td>Long Distance</td>
</tr>
<tr>
<td>Charger Type</td>
<td>Normal</td>
<td>Normal or Quick (depends on stay time)</td>
<td>Quick</td>
</tr>
<tr>
<td>Charging Site</td>
<td>Home Office</td>
<td>Super Market, Mall Restaurant or Parking Lot</td>
<td>Major Road Highway Service Area</td>
</tr>
</tbody>
</table>

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EV Market Readiness

• **Incentives for consumers**
  - Financial (tax credit, free permitting, free charging, subsidized charger installation)
  - Non-financial (HOV lane access, preferential parking, etc.)
  - *Time of use rates from utilities*
  - *Address issue of demand charges*

• **Streamlined EVSE permit process**
  - Fast, easy permit application process (online permitting)
  - Expedient installation approvals or installer self certification

• **Charging Infrastructure**
  - Home
  - Workplace
  - Public

• **Education and Public Outreach**
  - Educate the public on environmental, social, and financial benefits of electric drive vehicles
Roadblock: Installation Cost

- High installation cost in the US.
- There seems some space for reducing cost.

Transformer related:
- High utility interconnect fees
- Requirements on cost for an additional transformer for QC

Permission related:
- Installation costs increase for equipment weighing more than 400 lbs since structural engineer needed to approve drawing for permit

Cost Structure of total system

- 72%
- 23%
- 5%
Roadblock: Operation Cost (Demand Charge)

- High electricity rates cause hesitation for installing quick charging stations.

Rough estimation of monthly electricity rate for one station

<table>
<thead>
<tr>
<th>Utility</th>
<th>Summer On-Peak Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG &amp; E (San Francisco Area)</td>
<td>$570 /Month + $0.13 /kWh</td>
</tr>
<tr>
<td>SDG &amp; E (San Diego Area)</td>
<td>$1,401 /Month + $0.09 /kWh</td>
</tr>
</tbody>
</table>

* Demand charge calculated based on 50kW QC.
Appendix
EVs & FCEV Introduction

- Introduce 4 EVs including Nissan LEAF
- Prepare introduction of mass-production FCEV
EV drivers prefer public electric charging stations to alternatives. Free parking also high on the list.
### Roadblock: Operation Cost

Power required for EV charge have only a limited impact to the grid, even if all available QC stations used at the same time.

<table>
<thead>
<tr>
<th>Utility</th>
<th>Number of QC Stations</th>
<th>Peak power impact</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Max EV load**</td>
<td>Average output capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(MW) 1</td>
<td>(MW) 2</td>
</tr>
<tr>
<td>PG &amp; E (San Francisco Area)</td>
<td>80</td>
<td>4</td>
<td>10,800</td>
</tr>
<tr>
<td>SDG &amp; E (San Diego Area)</td>
<td>30</td>
<td>1.5</td>
<td>1,900</td>
</tr>
</tbody>
</table>

**In case all QC stations (50kw) operated at the same timing**
Nissan LEAF Satisfaction

- Overall satisfaction: 99% of owners are satisfied
- Autonomy range: 85% of owners responded positively

**Overall Satisfaction:**
- 99% Completely Satisfied
- 6% Very Satisfied
- 1% Satisfied
- 1% Not Very Satisfied
- 1% Not at all Satisfied

**Power & Performance Satisfaction:**
- 98% Completely Satisfied
- 16% Very Satisfied
- 1% Satisfied
- 1% Not Very Satisfied
- 1% Not at all Satisfied

**Autonomy Range Satisfaction:**
- 86% Completely Satisfied
- 29% Very Satisfied
- 8% Satisfied
- 14% Not Very Satisfied
- 2% Not at all Satisfied

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LEAF Customers: Potential Needs

- QC optional coupler: more than 80% of customers chose QC coupler

QC coupler

Normal coupler

DC Quick Charger at Public site

AC Normal Charger at Home
Priorities: towards EV expansion

- Deploy the infrastructure as quick as possible, and should not wait until the next technologies come.
- Make good use of on-going & past infrastructure investments.
- The priority is, instead of just focusing on connector type, to secure as much commonization as possible in major portion of the system.

Cost Structure of total system

- **Base Construction**
  - Transformer
  - Permission
  - Conduit & Wire
  - Concrete/Asphalt
  - Project management
  - Other equipment

- **Charger**
  - 5%

- **Connector**
  - 72%

- **Ground**
  - 23%
Several proposals exist at international level (IEC). China has issued its national standards. US and European standards are supposed to be finalized in a year or two.

Nissan, applying CHAdeMO type, does not believe it is the only and best, but it is the only available technology at this time.

Nissan predicts, from market experience, that it takes some time for the other technologies become ready, regardless of the status of the standardization.

<table>
<thead>
<tr>
<th>Connector Type for DC QC</th>
<th>Japan</th>
<th>US</th>
<th>Europe</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAdeMO</td>
<td><img src="image1" alt="CHAdeMO" /></td>
<td><img src="image2" alt="Combo" /></td>
<td><img src="image3" alt="Combo" /></td>
<td><img src="image4" alt="CHAdeMO" /></td>
</tr>
<tr>
<td>Combo</td>
<td><img src="image2" alt="Combo" /></td>
<td><img src="image3" alt="Combo" /></td>
<td><img src="image3" alt="Combo" /></td>
<td><img src="image4" alt="Combo" /></td>
</tr>
</tbody>
</table>
CA Market Expansion and ZEV Mandate

- EV cumulative volume in CA by major manufactures

**NOTE** Governor’s Executive Order

**by 2020:** The State’s zero-emission vehicle infrastructure will be able to support up to **one million vehicles**

**by 2025:** **Over 1.5 million zero-emission vehicles** will be on California roads and their market share will be expanding
Study with UC-Davis: QC Locations (1)

- This shows where the QCs would be necessary while driving

QC Demand Locations
Study with UC-Davis: QC Locations (2)

- Major retail stores like Safeway, Target, and Costco are located on or adjacent to the QC demand locations.
The Connected Vehicle

- 24-hour connection, extensive trace data (customer opt-in)

Track of only 2500 LEAFs in 7 months (Aug. 2011)
Cost Reduction

- Drastic cost reduction to expand application

Battery
- Improve energy density (Bat. Cell)
- Improve packaging efficiency (Bat. Pack)

Motor / Inverter
- Reduce rare earth usage (Motor)
- Downsize semiconductor (Inverter)

Charger, DC-DC etc.
- Integrate components (Charger, DC-DC)
- Improve space efficiency of e-PT
Vehicle Technologies for Range Extension

- Continuous efforts for range extension

- **Electric power source**
  - Higher energy density
  - Low deterioration

- **Aerodynamics**
  - Lower Cd

- **Auxiliary parts & system efficiency**
  - Air conditioning system
  - Heat Insulating Body
  - Power electronics efficiency
  - Transmission efficiency

- **Weight Reduction**
  - Structure Optimization
  - Material Substitution (High-tensile steel, Aluminum)

- **Energy management / Regeneration**
  - Regenerative Braking System

- **Running Resistance**
  - RRC tire
  - Brake Caliper friction

- **Battery**
  - Higher energy density
  - Low deterioration