Disclaimer: The views expressed are those of Paul Gipe and are not necessarily those of the sponsor.

Disclosure: Paul Gipe has worked with Aerovironment, ANZSES, An Environmental Trust, APROMA, ASES, AusWEA, AWEA, David Blittersdorf, Jan & David Blittersdorf Foundation, BWEA, BWE, CanWEA, Canadian Co-operative Assoc., CAW, CEERT, Deutsche Bank, DGW, DSF, EECA, ES&T, GEO, GPI Atlantic, IREQ, KWEA, MADE, Microsoft, ManSEA, MSU, NRCan, NRG Systems, NASA, NREL, NZWEA, ORWWG, OSEA, Pembina, PG&E, SeaWest, SEI, TREC, USDOE, WAWWG, WE Energies, the Folkecenter, the Izaak Walton League, the Minnesota Project, the Sierra Club, World Future Council, and Zond Systems, and written for magazines in the USA, Canada, France, Denmark, and Germany.

Paul Gipe, wind-works.org
Diesels are Dead
Long Live Electric Vehicles
By
Paul Gipe
VW Diesel Emission Scandal

• VW Violated Clean Air Standard ($NO_x$)
• In USA & Europe Using Software
• Proves Diesels Can Be Clean or Cheap
  But Not Both
• Little Room for Further Improvement

Paul Gipe, wind-works.org
VW Scandal Gives Push to EVs

Paul Gipe, wind-works.org
Why Drive Electric?

• Uses Fewer Resources
  More Efficient--High Mileage
• Zero Tail-Pipe Emissions
• 50%-70% Fewer Total Emissions
• Keeps Oil in the Ground
• Fun

Paul Gipe, wind-works.org
## EPA Mileage Ratings

### 2016 EPA Fuel Efficiency

<table>
<thead>
<tr>
<th>Mfg</th>
<th>Model</th>
<th>mpg</th>
<th>Type</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chevrolet</td>
<td>Spark</td>
<td>119</td>
<td>EV Compliance Car</td>
<td>Korea</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>e-Golf</td>
<td>116</td>
<td>EV Compliance Car</td>
<td>Germany</td>
</tr>
<tr>
<td><strong>Nissan</strong></td>
<td><strong>Leaf</strong></td>
<td>114</td>
<td><strong>EV</strong></td>
<td><strong>USA</strong></td>
</tr>
<tr>
<td>Kia</td>
<td>Soul Electric</td>
<td>105</td>
<td>EV Compliance Car</td>
<td>Korea</td>
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<tr>
<td><strong>Tesla</strong></td>
<td><strong>Model S</strong></td>
<td>101</td>
<td><strong>EV</strong></td>
<td><strong>USA</strong></td>
</tr>
<tr>
<td>Toyota</td>
<td>Prius c</td>
<td>50</td>
<td>Gas</td>
<td>Japan</td>
</tr>
<tr>
<td>Toyota</td>
<td>Prius V</td>
<td>42</td>
<td>Gas</td>
<td>Japan</td>
</tr>
<tr>
<td>Fiat</td>
<td>500</td>
<td>34</td>
<td>Gas</td>
<td>Mexico</td>
</tr>
<tr>
<td>Average LDV</td>
<td></td>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NO\textsubscript{x} Tail-Pipe Emission Scandal

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Emissions (g/mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf EV</td>
<td>0.05</td>
</tr>
<tr>
<td>EPA Fleet</td>
<td>0.30</td>
</tr>
<tr>
<td>SUV</td>
<td>0.50</td>
</tr>
<tr>
<td>2008 SUV</td>
<td>0.85</td>
</tr>
<tr>
<td>VW Jetta</td>
<td>1.30</td>
</tr>
<tr>
<td>VW Passat</td>
<td>2.65</td>
</tr>
</tbody>
</table>
Total EV $\text{CO}_2\text{e}$ Emissions

- Batteries Add Few Relative Emissions Even with 1-2 Battery Replacements!
- Most Emissions from Fuel

Source: UCS, Cleaner Cars from Cradle to Grave 2015

Paul Gipe, wind-works.org
CO$_{2e}$ Emissions by Source

It’s All about the Mix of Resources.

- Coal
- Natural Gas
- Biomass
- Solar
- Geothermal
- Nuclear
- Wind
- Hydro

Argonne National Lab., Geothermal Life-Cycle Assessment, November 2012, p 45.

Paul Gipe, wind-works.org
EVs CO$_2$e Cradle-Grave Emissions

- **New York State:** 135 mpg  
  Includes 30% Hydro in Mix
- **California:** 87 mpg  
  2/3 Fossil Fuels in “Green” California Mix  
  Only 10% New Renewables!
- **USA:** 68 mpg  
  Lots of Coal in Generating Mix  
  Average 2014 US LDV: 28 mpg

Source: UCS, Cleaner Cars from Cradle to Grave 2015

Paul Gipe, wind-works.org
EVs CO$_{2e}$ Cradle-Grave Emissions

U.S. average (EV sales-weighted): 68 MPG

Learn more at: ucsusa.org/EVlifecyle

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Paul Gipe, wind-works.org
Our Nissan Leaf $CO_{2e}$ Cradle-Grave

- 29% of ICE (including battery)
- 60% of Plug-in Hybrid

A 2015 Nissan LEAF (24 kWh) charged in 93305 produces about as much global warming pollution as a gasoline vehicle getting 97 miles per gallon.

UCS, 2015: [Gasoline vs Electric—Who Wins on Lifetime Global Warming Emissions? We Found Out](http://wind-works.org)

Paul Gipe, wind-works.org
EV Sales Growing: Costs Declining

**Electric Vehicles**

$/kWh

- 2009: Modeled Battery Cost
- 2010: Modeled Battery Cost
- 2011: Modeled Battery Cost
- 2012: Modeled Battery Cost
- 2013: Modeled Battery Cost
- 2014: Modeled Battery Cost

Cumulative EV Vehicle Sales

Notes: Costs are modeled costs for high-volume battery systems, derived from DOE/UIS Advanced Battery Consortium PHEV Battery development projects and are representative of nominal dollars. Sales as reported by market tracker, here “EVs” include all plug-in hybrid and battery plug-in vehicles.


Paul Gipe, wind-works.org
Adoption of EVs Accelerating

- EVs 1.6% of Vehicle Sales—Today
- Adoption Faster than Prius
- CA Goal: 1.5 million ZEVs, 2025
  10% of 15 Million Passenger Vehicles

Paul Gipe, wind-works.org
What is an EV?

• It Is Just a Car
  4 Wheels, Steering Wheel, but No Engine

• Has a Very Small “Gas Tank”
  Today Range is Limited: 60-80 miles
  2017 Range: 200 miles

• There are Very Few “Gas Stations”
  “Green” California is a Laggard
  Most Charge at Home

Paul Gipe, wind-works.org
An EV Has a Motor but No Engine

Paul Gipe, wind-works.org
An EV Has a Traction Battery

Nissan Leaf: Purpose-Built Traction Battery under the Floor & Seats.

Paul Gipe, wind-works.org
EV Range = kWh Traction Battery

- 2015 Leaf: 24 kWh
- 2016 Leaf: 30 kWh
- 2017 Leaf: 60 kWh?
- Tesla S: 60 kWh

kWh = Size of the Gas Tank.

Paul Gipe, wind-works.org
“Filling the Gas Tank”
Charging the Traction Battery

Paul Gipe, wind-works.org
EV Charge Levels

- **L1**: Painfully Slow (120 V); 24 hrs
  Emergencies Only

- **L2**: Better (240 V, <50 A); 3-4 hrs
  Home Charging, Businesses, Schools

- **L3**: Best (400 V, 100 A); 20 mins
  DC Fast or Quick Charge (DCFC, DCQC)
  Commercial Sites: Shopping Centers & Dealerships

Paul Gipe, wind-works.org
Installing Home Charge Station

Paul Gipe, wind-works.org

Louie Luna & Chuck Crowell, Croad Electric
EV Home Charge Station

- J1772 EV Plug
- EVSE 240 V, 40 A
- kWh Meter
- Switch
- NEMA 14-50 Receptacle

Paul Gipe, wind-works.org
Charge Levels & Charge Ports

• J1772 (in the US & Canada)
  240 Volts, <50 Amps,
  The “Plug”

Paul Gipe, wind-works.org
J1772 Standard Level 2 Plug

Paul Gipe, wind-works.org
Nissan Leaf L2 Charging

- 1 hr to add 40% SOC
- 65% SOC in 2 hrs to add
- 97% SOC in 2 hrs 25 mins to add 80% SOC
- 95% SOC taper begins in 1 hr
- 17% SOC

Note: 240 V, 27.5 A (40 A circuit)

Paul Gipe, wind-works.org
## EV Cost: Nissan Leaf

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nissan Leaf S</td>
<td>$33,000</td>
</tr>
<tr>
<td>Federal Subsidy</td>
<td>-$7,500</td>
</tr>
<tr>
<td>State Subsidy</td>
<td>-$2,500</td>
</tr>
<tr>
<td>SJVAPCD Subsidy</td>
<td>-$3,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$20,000</strong></td>
</tr>
</tbody>
</table>

Paul Gipe, wind-works.org
# EV Cost: Home “Gas Pump”

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>240 V, 40 A EVSE</td>
<td>$650</td>
</tr>
<tr>
<td>Metering &amp; Switches</td>
<td>$500</td>
</tr>
<tr>
<td>Installation</td>
<td>$1,350</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$2,500</strong></td>
</tr>
</tbody>
</table>

Paul Gipe, wind-works.org
EV Charging Consumption

Gipe-Nies 2015 Nissan Leaf

Electric Usage This Period: 253,000,000 kWh, 30 billing days

--- = Average Daily Usage 8.43 kWh
# Fuel Cost Comparison

## Gasoline Cost per Mile

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
<td>Prius</td>
</tr>
<tr>
<td>$/gal</td>
<td>mpg</td>
<td>$/mi</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

Gasoline cost only.

## Electricity Cost per Mile

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Cost</th>
</tr>
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<tbody>
<tr>
<td>$/kWh</td>
<td>mi/kWh</td>
</tr>
<tr>
<td>0.166</td>
<td>3.8</td>
</tr>
</tbody>
</table>

$0.04

Electricity cost only

2/3 Cost of a Prius; 1/3 Cost of Standard ICE.

Paul Gipe, wind-works.org
EV Cost: Fuel

- Year 1: 7,000 miles
- Year 1: $250

Paul Gipe, wind-works.org
EV Intercity Travel
Can Be Challenging
Must Plan Carefully
Use Plugshare

Plugshare.com

Paul Gipe, wind-works.org
EV Intercity Travel--Adventures

• 3 Trips to the Coast
• To LAX via Tehachapi
• Kernville
• Ridgecrest
• Visalia

Paul Gipe, wind-works.org

Lost Hills RV Park: Level 2
Portable (Emergency) Charge Cable

- All EVs Include a Portable L1 Charge Cable
- Can Be Modified to L2 for Use on the Road

Paul Gipe, wind-works.org

EVSE Upgrade, Nissan Leaf
Portable Charge Cable

Portable EVSE

Shorepower:
Flying J Truck Stop
Lebec, California

Paul Gipe, wind-works.org
DC Fast-Charging Makes Intercity Travel Possible

40 kW vs 6 kW

Paul Gipe, wind-works.org
DC Fast-Charge Standards

• CHAdeMO
  Japanese cars: Nissan & Mitsubishi

• CCS (Combined Charging System)
  American & European cars: VW, BMW, Ford

• Tesla
  Well, Tesla does it own thing...
Nissan Leaf Charge Ports

CHAdeMO DCFC
L3: 40 kW

J1772
L2: 6 kW
DC Fast Charging

Pacific View Mall North
Ventura, California

40 kW: 30 mins.

Paul Gipe, wind-works.org
West Coast Electric Highway

- DCFC Network
- North-South
- East-West
- Years Behind Oregon & Washington

Paul Gipe, wind-works.org
EV Revolution—Not Just USA

Auto Bleue EV Car Sharing France

Paul Gipe, wind-works.org
EV Auto Share—Nice, France

Paul Gipe, wind-works.org
Near Koblenz, Germany

Paul Gipe, wind-works.org
Vienna to Jutland, Denmark 2005!

Paul Gipe, wind-works.org
VW Penalties Wish List

- Permit Only VW EVs in US
- Minimum of 50,000/yr 200-mile EVs
- Install Nationwide Fast-Charging System
- Require Dedicated EV Plant on US Soil
  $1-2 Billion
- Build It in Bakersfield
  In the Heart of the Oil Patch
  & Richard Beene’s Backyard

Paul Gipe, wind-works.org
EV CHARGING ONLY