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
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

<table>
<thead>
<tr>
<th></th>
<th>Vehicle</th>
<th>Comb.</th>
<th>City/Hwy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hyundai Ioniq Electric</td>
<td>136</td>
<td>150/122</td>
</tr>
<tr>
<td></td>
<td>Automatic (A1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Tesla Model 3 Long Range</td>
<td>130</td>
<td>136/123</td>
</tr>
<tr>
<td></td>
<td>Automatic (A1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Chevrolet Bolt EV</td>
<td>119</td>
<td>128/110</td>
</tr>
<tr>
<td></td>
<td>Automatic (A1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Volkswagen e-Golf</td>
<td>119</td>
<td>126/111</td>
</tr>
<tr>
<td></td>
<td>Automatic (A1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>BMW i3 (94Ah)</td>
<td>118</td>
<td>129/106</td>
</tr>
<tr>
<td></td>
<td>Automatic (A1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>BMW i3s (94Ah)</td>
<td>112</td>
<td>126/99</td>
</tr>
<tr>
<td></td>
<td>Automatic (A1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Nissan Leaf</td>
<td>112</td>
<td>125/100</td>
</tr>
<tr>
<td></td>
<td>Automatic (A1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Paul Gipe, wind-works.org
NO\textsubscript{x} Tail-Pipe Emission Scandal

The Law

Leaf EV
EPA Fleet
SUV
2008 SUV
VW Jetta
VW Passat

Paul Gipe, wind-works.org
Total EV CO$_{2e}$ 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
It’s All about the Mix of Resources.

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

**g/kWh**

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

Paul Gipe, wind-works.org
Wheels-to-Wheels Efficiency by Energy Source ghg

- Oil
- Coal
- Gas
- Geothermal
- Solar
- Nuclear
- Wind
- Hydro

I/100 km

UCS 2017

Paul Gipe, wind-works.org
EVs CO$_{2e}$ 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 14% 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$_2$e Cradle-Grave Emissions

2012 Data

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

2017 Data

[Map showing EVs CO$_2$e Cradle-Grave Emissions across the United States with different states highlighted in varying shades of blue to indicate different MPG ranges. The map is credited to the Union of Concerned Scientists.]
Our Nissan Leaf CO$_2$e Cradle-Grave

- 29% of ICE (including battery)
- 60% of Plug-in Hybrid
- 2 l/100 km

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

Paul Gipe, wind-works.org
Our Chevy Bolt 131 mi/g

• 1.8 l/100 km

A 2017 Chevrolet Bolt charged in 93305 produces about as much global warming pollution as a gasoline vehicle getting 131 miles per gallon.
**EV Sales Growing: Costs Declining**

**Electric Vehicles**

$/kWh

- $1,200
- $1,000
- $800
- $600
- $400
- $200
- $0

**Modeled Battery Cost**

**Cumulative EV Vehicle Sales**

- 2009
- 2010
- 2011
- 2012
- 2013
- 2014

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 Less Limited
  2018 Range: 250-400 km

• There are Very Few “Gas Stations”
  “Green” California Remains a Laggard
  Quebec & Ontario
  Most Charge at Home

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

High-Voltage Cables to Traction Battery

80 kW Motor

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
2017 Chevy Bolt EV

DC & AC Charge Port
Skateboard Battery
Regenerative Braking

Paul Gipe, wind-works.org
Chevy Bolt’s Innards

Orange = High Voltage

Paul Gipe, wind-works.org
Chevy Bolt EV

Paul Gipe, wind-works.org
Chevy Bolt Trunk

- Trunk < Nissan Leaf
- Adequate

Paul Gipe, wind-works.org
Chevy Bolt EV Wheel Well

Towing Eye

Portable EVSE
120 V - 240 V

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

2015 Leaf
2016 Leaf
2017 Leaf
Chevy Bolt
Tesla 3 LR

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
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
## 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
Our Cost to Lease Chevy Bolt EV

- 3-year Lease Fee: $9,000 USD
- State & Local Subsidies: -$6,000 USD
- Net Cost: $3,000 USD
- Net Cost: $83/Month
- Less Fuel Savings: $65/mo
- Amortized Expenses: 240 V, 40 A EVSE

Paul Gipe, wind-works.org
EV Charging Consumption

Gipe-Nies 2015 Nissan Leaf

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

Paul Gipe, wind-works.org
EV & Electricity Consumption

- Nies-Gipe: 3,500 kWh/year
- Nies-Gipe & EV: 4,100 kWh/year (3,300), 1,800 kWh/year (1,800)
- Avg CA Home: 6,500 kWh/year

Paul Gipe, wind-works.org
Typical EV Electrical Consumption

Paul Gipe, wind-works.org

km per Year

5000

10000

20000

kWh/year

km/kWh

5.6

6

6.4

Paul Gipe, wind-works.org
EV Intercity Travel

- Can Be Challenging
- Must Plan Carefully
- Use Plugshare

Charging Desert

Paul Gipe, wind-works.org
Life with an EV

• Plan the Drive, Drive the Plan
• Range & Range Anxiety
• Range Estimators
  Temperature, Speed, Elevation, & Wind
• Maintain a Reserve
  15%-20%
• Plan B for when Plan A Fails

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

- 4 Trips to the Coast
- 2 Trips to LAX
- Kernville, Ridgecrest, Visalia
- Palm Springs (800 km) Roundtrip

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
DC Fast-Charging Makes Intercity Travel Possible

40 kW vs 6 kW

Press the STOP button to stop charging.

Left 27 min.

106A 389V

3m37s

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

Paul Gipe, wind-works.org
Chevy Bolt CCS Charge Port

Charge Latch

DC Port

DC Port Cover

Paul Gipe, wind-works.org
DC Fast Charging

Pacific View Mall North
Ventura, California

40 kW: 30 mins.

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
On-Street Charging—Rome, Italy

BMW i3, Enel L2

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
North American Passenger Vehicle Consumption

- 1,200 TWh/yr for EVs
- 3,200 TWh/yr for Fossil-Fired Generation in North America

Paul Gipe, wind-works.org
EV CHARGING ONLY