EVs in Ontario: Current State, Outlook, and Grid Optimization
Matt Stevens, Ph.D., CEO of FleetCarma

1. Current state of EVs in Canada & Ontario
2. Outlook for EVs in Ontario
3. ChargeTO & Other Utility Initiatives
**Best Plan**

*Ryan:* Design cities so you can walk.

**Backup Plan**

*Josipa:* Take public transit.

**Backup to the Backup Plan:**

*Matt:* Drive an EV.
## Electric Vehicle Fleet in Canada

### As of December 31, 2015

<table>
<thead>
<tr>
<th>BEV Labels</th>
<th>Alberta</th>
<th>British Columbia</th>
<th>Manitoba</th>
<th>New Brunswick &amp; Labrador</th>
<th>Newfoundland &amp; Labrador</th>
<th>Northwest Territories</th>
<th>Nova Scotia</th>
<th>Ontario</th>
<th>Island</th>
<th>Quebec</th>
<th>Saskatchewan</th>
<th>Yukon</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW i3</td>
<td>228</td>
<td>2419</td>
<td>58</td>
<td>15</td>
<td>3</td>
<td>2</td>
<td>52</td>
<td>3428</td>
<td>7</td>
<td>3797</td>
<td>24</td>
<td>1</td>
<td>10034</td>
</tr>
<tr>
<td>CHEVROLET SPARK</td>
<td>1</td>
<td>108</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>61</td>
<td>74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FORD FOCUS</td>
<td>6</td>
<td>40</td>
<td>1</td>
<td>73</td>
<td>122</td>
<td>2</td>
<td>244</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KIA SOUL</td>
<td>1</td>
<td>105</td>
<td>73</td>
<td>178</td>
<td>357</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MITSUBISHI IMIEV</td>
<td>12</td>
<td>112</td>
<td>5</td>
<td>2</td>
<td>117</td>
<td>374</td>
<td>1</td>
<td>627</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NISSAN LEAF</td>
<td>45</td>
<td>932</td>
<td>32</td>
<td>6</td>
<td>1</td>
<td>29</td>
<td>852</td>
<td>5</td>
<td>1797</td>
<td>7</td>
<td>3709</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMART FORTWO</td>
<td>10</td>
<td>219</td>
<td>2</td>
<td>541</td>
<td>333</td>
<td>1105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TESLA MODEL S</td>
<td>137</td>
<td>883</td>
<td>17</td>
<td>5</td>
<td>1</td>
<td>20</td>
<td>1637</td>
<td>879</td>
<td>10</td>
<td>3590</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TESLA ROADSTER</td>
<td>16</td>
<td>18</td>
<td>2</td>
<td>54</td>
<td>14</td>
<td>2</td>
<td>106</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOYOTA RAV4</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HYUNDAI IONIQ</td>
<td>195</td>
<td>907</td>
<td>54</td>
<td>33</td>
<td>10</td>
<td>1</td>
<td>21</td>
<td>2516</td>
<td>2</td>
<td>4674</td>
<td>26</td>
<td>0</td>
<td>8441</td>
</tr>
<tr>
<td>AUDI A3</td>
<td>9</td>
<td>15</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMW i3 REX</td>
<td>140</td>
<td>1</td>
<td>1</td>
<td>128</td>
<td>85</td>
<td>355</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMW i8</td>
<td>6</td>
<td>83</td>
<td>109</td>
<td>31</td>
<td>229</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CADILLAC ELR</td>
<td>2</td>
<td>12</td>
<td>24</td>
<td>31</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEVROLET VOLT</td>
<td>107</td>
<td>445</td>
<td>37</td>
<td>25</td>
<td>7</td>
<td>1</td>
<td>11</td>
<td>1669</td>
<td>2</td>
<td>3766</td>
<td>18</td>
<td>6088</td>
<td></td>
</tr>
<tr>
<td>FISKER KARMA</td>
<td>9</td>
<td>24</td>
<td>40</td>
<td>27</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FORD C-MAX</td>
<td>19</td>
<td>58</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>184</td>
<td>0</td>
<td>290</td>
<td>3</td>
<td>564</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FORD FUSION</td>
<td>15</td>
<td>47</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>149</td>
<td>0</td>
<td>235</td>
<td>2</td>
<td>456</td>
<td></td>
<td></td>
</tr>
<tr>
<td>McLAREN P1</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PORSCHE 918</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PORSCHE CAYENNE</td>
<td>20</td>
<td>50</td>
<td>3</td>
<td>1</td>
<td>95</td>
<td>42</td>
<td>1</td>
<td>213</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PORSCHE PANAMERA</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOYOTA PRIUS</td>
<td>10</td>
<td>30</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>194</td>
<td>0</td>
<td>149</td>
<td>1</td>
<td>0</td>
<td>289</td>
<td></td>
</tr>
<tr>
<td>Grand Total</td>
<td>423</td>
<td>3326</td>
<td>112</td>
<td>48</td>
<td>13</td>
<td>3</td>
<td>73</td>
<td>5944</td>
<td>9</td>
<td>8471</td>
<td>50</td>
<td>1</td>
<td>18475</td>
</tr>
</tbody>
</table>
Electric Vehicle Fleet in Canada
Provincial Summary

Total Plug-In Vehicles by Province
As of December 31, 2015

18,475 total
QC: 8,471
ON: 5,944
BC: 3,326

Fraction of fleet:
Canada: 0.09%
QC: 0.17%
Ontario: 0.08%
BC: 0.12%
Electric Vehicle Fleet in Ontario
Model Breakdown – Dec 2015

- TESLA MODEL S, 1637, 28%
- CHEVROLET VOLT, 1669, 28%
- NISSAN LEAF, 852, 14%
- FORD FUSION, 149
- SMART FORTWO, 541
- FORD C-MAX, 184
- Other, 912

Model Breakdown:
- TESLA MODEL S, 1637, 28%
- CHEVROLET VOLT, 1669, 28%
- NISSAN LEAF, 852, 14%
- FORD C-MAX, 184
- SMART FORTWO, 541
- FORD FUSION, 149
- Other, 912
Electric Vehicle Fleet in Canada
Model Difference Between Ontario and Canada

Canada
- CHEVROLET VOLT, 6088, 33%
- NISSAN LEAF, 3709, 20%
- TESLA MODEL S, 3590, 19%
- FORD C-MAX, 584
- SMART FORTWO, 1105
- MITSUBISHI IMIEV, 627
- Other, 2782

Ontario
- CHEVROLET VOLT, 1669, 28%
- TESLA MODEL S, 1637, 28%
- NISSAN LEAF, 852, 14%
- FORD C-MAX, 184
- FORD FUSION, 109
- SMART FORTWO, 541
- Other, 912

EVs in Ontario: Current State, Outlook, and Grid Optimization
Pollution Probe: Pathways Initiative Workshop
Electric Vehicle Fleet
Month to Month Sales in Ontario

Total Ontario PEV sales ~200/month.

Tesla dominated 2015 in Ontario.
Ontario has been falling behind BC and Quebec.

Ontario:
- 0.7% of car sales
- 0.3% of LDV sales
1 Current state of EVs in Canada & Ontario
2 Outlook for EVs in Ontario
3 ChargeTO & Other Utility Initiatives
By matching Quebec & BC’s sales rates, Ontario sales would hit 600 units/month.

With other factors expected to hit **700-800**/month in 2016.

Tesla incentives reduced; however, this impact is expected to be modest.
$200/kWh is the “magic number” for battery costs.
Cell costs of $145/kWh implies a pack cost of $190-200/kWh
Battery costs are reducing faster than forecasted.

Nine month outlook:
- Battery prices are “there”
- Ontario DCFC issue is solved

Now if we can just not trip on ourselves....
Bars to EV Adoption
The Anti-Aphrodisiacs

Can we please fix these?
1. Current state of EVs in Canada & Ontario
2. Outlook for EVs in Ontario
3. ChargeTO & Other Utility Initiatives
Mo’ Money
Mo’ Problems.

Mo’ EVs
Mo’ Problems.
Most PHEVs: 3.3kW, 3-4 hours

Older BEVs (non-Tesla): 3.3kW, 7-8 hours

Household Feeder Sizing (50kVA): 6.6kW, 1.5-2 hours

Newer BEVs (non-Tesla): 6.6kW, 3-4 hours

Tesla with Single Charger: 9.6kW, 7-10 hours

Tesla with Twin Charger: 19kW, 3.5-5 hours

Average charging power is increasing for BEVs
Funded through the Ontario Ministry of Energy’s Smart Grid Fund.

The project team includes:
- Ministry of Energy
- Toronto Hydro
- AddÉnergie Technologies
- FleetCarma (aka CrossChasm)

Networked EVSE partner:

[Image: AddENERGIE Smart Charging Solutions]
Had over 100 people register for the 30 spots.

Enrolled Model S, Volt, LEAF, i3, and smart fortwo owners.

First of its type in the World.
EV Owner:  Get me fully charged by 6am. Don’t ever slow me down if I’m below 10%.

Utility:  Keep the total charging loads of this group of EVs to under 10kW.

The system then manages the system based on the criteria above.
### Charging Types

**Smart-Charging Intro**

- **Dumb Charging**
  - Charging begins as soon as you plug in.

- **Scheduled Charging**
  - Charging is delayed until a preset start time or to finish at a specific end time.
  - **Delayed: Start Time**
    - Start charging at 7pm
  - **Delayed: Departure Time**
    - Finish charging at 7am

- **Smart Charging**
  - Charging may begin immediately but can be reduced/delayed based upon external factors. Partial control may be given to 3rd party (e.g., utility or building).
  - **Without Vehicle-Side Data**
    - System is blind to the vehicle’s needs.
  - **With Vehicle-Side Data**
    - Vehicle needs are known.
Baseline Charging Behaviour

“Dumb” Charging

Typical Peak Loads
5:00-8:00 pm

Daily Utilization

50% of ChargeTO Participants

EVs in Ontario: Current State, Outlook, and Grid Optimization
Pollution Probe: Pathways Initiative Workshop
Baseline Charging Behaviour – Unmanaged Charging

Average Charging Load Weekday

Daily Average Charger Power Consumption by Month

- February
- March
- April
- May
- June

Time of Day [hours]

Average Power [kW]
Baseline Charging Behaviour – Unmanaged Charging
Forecasting a given week in Ontario in June

EV Charging Load Growth

109 MW peak (Dec 2019)
27kW curtailment overnight
The Three Most Important Results

150+ days of active curtailment

85% temporary reduction in peak charging load

50-55% reduction in daily peak charging load.

This is the % of peak load that can be shed every night.

This is load that can be shed for a temporary period (<1hr)

More than was expected at the start of the project?
What other load could be cut in half every day?

(or timed with renewables?)
What impact did Smart Charging have on your vehicle usage?

- Very negative: 0%
- Negative: 10%
- Neutral: 60%
- Positive: 20%
- Very positive: 10%
Mo’ EVs
Mo’ Highly Valuable Grid Assets.
What is the role of the Utility in EV adoption? Should they be permitted to go beyond the meter?

**EV Indifferent**

EVs are a load on the system that will be services like any other load. No need for utility notification or engagement.

**EV Engaged**

I want to be engaged with EV owners – receiving utility notifications, running targeting EV engagement programs and deliberate conversion of our own fleet.

**The EV Leader**

When anyone in my service area thinks EVs I want the utility to be the first person they call. I want to develop new revenue generating products/services and heavily promote EVs in my service area.
Some of FleetCarma’s Clients

International Footprint

- World’s leading EV monitoring system
- More than 40 EV models supported
- Patented EV modelling software
- Over 150 clients with deployments in 23 countries including major utilities, municipalities, states, and universities
Products in 23 countries > Team of 21 people

But we’re hiring (so if you know someone...)
My Boss: “Say Dank You!”
Thank You For Your Time!

Matt Stevens
mstevens@fleetcarma.com
519.404.5987 (cell)
Incentive Plan

How can we most efficiently make vehicles more available for curtailment?

1) Three reward options: personal (gift certificate), social (kiva.org), environmental (bullfrog)
2) Two incentive groups, compared to a control group with no incentive:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Value</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Champion</td>
<td>$20</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 0-5%</td>
</tr>
<tr>
<td>Ambassador</td>
<td>$15</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 10-19%</td>
</tr>
<tr>
<td>Leader</td>
<td>$10</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 20-29%</td>
</tr>
<tr>
<td>Pro</td>
<td>$5</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 30-39%</td>
</tr>
<tr>
<td>Participant</td>
<td>$0</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 40-50%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Value</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Champion</td>
<td>$0</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 0-5%</td>
</tr>
<tr>
<td>Ambassador</td>
<td>$5</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 10-19%</td>
</tr>
<tr>
<td>Leader</td>
<td>$10</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 20-29%</td>
</tr>
<tr>
<td>Pro</td>
<td>$15</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 30-39%</td>
</tr>
<tr>
<td>Participant</td>
<td>$20</td>
<td>Maintaining the &quot;SOC Auto Opt-Out&quot; setting between 40-50%</td>
</tr>
</tbody>
</table>

Group 1: Opt-in Incentive (+$0.50 for each day opted-in)

Group 2: Opt-out Incentive (-$0.50 for each day opted-out)
Incentive Phase Results - SOC Auto Opt-Out Setting

Minimum % SOC Required:
Before

Minimum % SOC Required:
After

% of Participants

% SOC

0% 10% 20% 30% 40% 50%
Average Reward: $43

13/18 participants changed their settings in order to get a better reward

<table>
<thead>
<tr>
<th>Group</th>
<th>Before</th>
<th>After</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count up Incentive</td>
<td>40%</td>
<td>19%</td>
<td>-21%</td>
</tr>
<tr>
<td>Count down Incentive</td>
<td>33%</td>
<td>13%</td>
<td>-20%</td>
</tr>
<tr>
<td>Incentive Group Average</td>
<td>36%</td>
<td>16%</td>
<td>-20%</td>
</tr>
<tr>
<td>Control Group</td>
<td>34%</td>
<td>34%</td>
<td>0%</td>
</tr>
</tbody>
</table>
How interested would you be in a program like this one with 30% less electricity costs, and a battery warming feature? (Scale of 1-5, 5 highest)
Role of the Utility?

- Ability for EVs to reduce costs for all ratepayers
- Experts in infrastructure deployment
- Watching California & Portland activities, balancing utility role with competition/innovation

Role of EVs in the General EV Market?

- Minimum bid size?
Two core EV objectives

1. Enjoy EVs (and their ROI)
   - EV monitoring with utilization goals
   - EV smart charging technology

2. Adopt EVs (wisely)
   - ICE vehicle telematics and GPS
   - with
   - EV suitability assessment modelling