How do two-car households experience a battery electric vehicle?

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The set-up

Inclusion criteria:
• Small changes: same home, same workplace, etc.
• High quality of data from baseline period.
• Positive response rate: ≈ 90%.

Result: 25 participating households
The EV: VW e-Golf

• Stated range: 170-190 km (~105-120 miles) - NEDC
• Experienced range 120 km (~75 miles)
The data

• GPS data on both conventional vehicles
• GPS data on conventional and EV
• Interviews before and after trial period
• Data from home-charging station

• 3 measurement periods
  • 10 households: April – September 2015
  • 10 households: October 2015 – January 2016
  • 5 households: February 2016 – May 2016
Target group first measurements period

*Households*
- Gothenburg region (13 municipalities)
- 2 cars (private, no company car)
- ≤ 65 years old (commuting)

*Cars*
- MY 2002+
- ≤ 2000 kg
- ≤ 200 kW

- Random selection from the vehicle register
- Recruitment by mail from households, + commuting ≥ 10km one way?
  + ≥ 2 actively used driving licences?

Spring 2013 and spring 2014
The data (II)

• 25 household
  • Gothenburg region, 2 cars, 1 replaced by EV,
  • Selected from 60 household previously measured GPS on both cars
    • Criteria: good data in measurement period 1; not major changes in commuting
The data (III)

• EV on trial
  • VW e-Golf – stated range 170 -190 km (experienced range 120 km)

• GPS frequency 1HZ
• From OBD: SOC (in %), odometer, outside temperature, engine power (1/minute)
• Home charging stations: starting time of charge, length of charge, energy (kWh)

• Interviews before and after EV trial
• Interested but not (only) early adopters
Histogram of daily driving distance compared to replaced car (aggregated for 10 households)
Histogram of daily driving distance compared to replaced car - aggregated + 3 cases
Histogram of daily driving distance compared to kept conventional vehicle (aggregated for 10 households)
Comparing daily driving distances between EV and ICE – aggregated + 3 cases
Share of driving and fractional increase in share of driving for EV

<table>
<thead>
<tr>
<th>Household</th>
<th>EV</th>
<th>Replaced car</th>
<th>Fractional increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>65%</td>
<td>63%</td>
<td>2%</td>
</tr>
<tr>
<td>2</td>
<td>32%</td>
<td>29%</td>
<td>12%</td>
</tr>
<tr>
<td>3</td>
<td>52%</td>
<td>20%</td>
<td>160%</td>
</tr>
<tr>
<td>4</td>
<td>59%</td>
<td>59%</td>
<td>-1%</td>
</tr>
<tr>
<td>5</td>
<td>45%</td>
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<td>7%</td>
</tr>
<tr>
<td>7</td>
<td>50%</td>
<td>48%</td>
<td>3%</td>
</tr>
<tr>
<td>8</td>
<td>35%</td>
<td>34%</td>
<td>4%</td>
</tr>
<tr>
<td>9</td>
<td>58%</td>
<td>52%</td>
<td>12%</td>
</tr>
<tr>
<td>10</td>
<td>57%</td>
<td>63%</td>
<td>-8%</td>
</tr>
</tbody>
</table>
Extrapolated annual VKT for both vehicles and total in the two measurement periods

Two ICE cars

One EV and One ICE
Some interview results

• Everyone liked the car
  • “It’s the future”
  • Driving experience, quiet
  • Exceeded expectations for almost all
• Limited range experienced as negative
  • “but we have managed all our driving”
• Insecurity:
  • How much range is actually left?
  • Will charging stations work?
  • Lifetime of battery – leasing more attractive than buying
• Price probably biggest barrier
  • Want similar price as conventional vehicle
Some observed behaviors

• Not many have taken long trips with EV
• Environmental rebound?
  • No bad conscience when driving EV
• Cold spell in winter had a negative effect on experience (including winter tires) – most estimate a reduction in range of 25%
• Experience of range much relate to attitude to risk taking
  • One woman – refills gas when half-empty
Early conclusions

- There is a large heterogeneity in how driving is adjusted to the use of a BEV.
- On average, the increase in driving the BEV is small
- Price is probably the largest barrier
Potential of electric driving