Making electric mobility happen:
Insights from a reflexive, multi-method research program

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Vancouver, Canada

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SPRU, University of Sussex
Moving beyond alternative fuel hype to decarbonize transportation
Noel Melton\(^1,2\), Jonn Axsen\(^3\) and Daniel Sperling\(^3\)

No free ride to zero-emissions: Simulating a region’s need to implement its own zero-emissions vehicle (ZEV) mandate to achieve 2050 GHG targets
Maxwell Sykes, Jonn Axsen

Evaluating plug-in electric vehicle policies in the context of long-term greenhouse gas reduction goals: Comparing 10 Canadian provinces using the “PEV policy report card”
Noel Melton\(^1,2\), Jonn Axsen\(^3\), Suzanne Goldberg\(^3\)

Confusion of innovations: Mainstream consumer perceptions and misperceptions of electric-drive vehicles and charging programs in Canada
Jonn Axsen, Brad Langman, Suzanne Goldberg\(^3\)
Overview

1) Why electric vehicles?
2) A multi-method, reflexive approach
3) Insights from interviews
4) From interviews to surveys
5) From surveys to models
6) From research to policy evaluation
1) Why electric vehicles?
Huge variety among plug-in vehicles

- **Plug-in Hybrid (PHEV)**
  - Toyota Prius PHV: 20 km, ~800 km gasoline
  - Chevy Volt: ~56 km, ~500 km gasoline

- **Pure Electric (EV)**
  - Nissan Leaf: ~117 km electric range
  - Tesla Roadster: ~300 km electric range

Comparing Battery Sizes:
- 4 kWh
- 16 kWh
- 24 kWh
- 53 kWh
Bigger picture: three-legs of the transport GHG mitigation “stool”

All legs need to be addressed...

Travel Demand (VKT)
Long-term modeling suggests that PEVs can play an important role in GHG mitigation.

Current Policies

“Ambitious” Policies (no ZEV mandate)

+ZEV mandate

2050 GHG Target
80% below 2005 GHGs

Source: Sykes and Axsen (2017), Energy Policy
...a socio-technical transition?

**Social**
- Learning and social influence
- Design interests
- Latent demand
- Awareness and confusion

**Technology**
- PEV policy
- Vehicle design
- Battery costs
- GHG and grid impacts
- Infrastructure needs
2) A reflexive, multi-method approach

- "Qualitative" interviews
  \( n = \text{dozens} \)

- "Quantitative" surveys
  \( n = 100\text{s or 1000s} \)

- Technology adoption models
  (0-15 year time horizon)

- Energy-economy system models
  (20-40yr + time horizon)

My Master’s work

Discrete choice model
Informing behavioural realism
2) A reflexive, multi-method approach

- “Qualitative” interviews
  - n = dozens

- “Quantitative” surveys
  - n = 100s or 1000s

- Technology adoption models
  - (0-15 year time horizon)

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  - (20-40yr + time horizon)

What is “social influence”? My Ph.D work
2) A reflexive, multi-method approach

- "Qualitative" interviews
  n = dozens

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  (0-15 year time horizon)

- Energy-economy system models
  (20-40yr + time horizon)

My latest work

- "Reflexive Participant" surveys
- "Respondent-based" modeling
- Behaviourally-realistic models
2) A reflexive, multi-method approach

- "Qualitative" interviews
  n = dozens

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My latest work

Policy evaluation
3) Insights from Interviews

“Qualitative” interviews
n = dozens

“Quantitative” surveys
n = 100s or 1000s

Technology adoption models
(0-15 year time horizon)

Energy-economy system models
(20-40yr + time horizon)

My latest work
PEV consumer research: “Pioneers” and the “Early Mainstream”

Potential “Early Mainstream” PEV buyers

New vehicle buyers

Source: Axsen et al. (2015), *Electrifying Vehicles*
Mainstream has low awareness...

The majority expressed confusion about **PEVs**:

“Is the Leaf electric or is it hybrid?” – Mr. Chen

“What’s the deal here? You don’t plug this in, the hybrid?” – Clair

And confusion about **vehicle-grid integration** and **V2G**.

“That gets pretty complicated…” – Andreas

“[seems] futuristic” – Clair

“Oh god!” – Christine (in confusion)

*Source: Axsen, Langman & Goldberg (2017), *Energy Research & Social Science*
Consumer perceptions are complex; as are processes of preference construction.

Sources: Axsen and Kurani (2012), *Environment and Planning A*
Axsen, Orlebar & Skippon (2013), *Ecological Economics*
Consumer perceptions are complex; as are processes of preference construction.

<table>
<thead>
<tr>
<th></th>
<th>Functional</th>
<th>Symbolic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private</strong></td>
<td>What it does for you</td>
<td>What it represents</td>
</tr>
<tr>
<td><strong>Societal</strong></td>
<td>What it does for society</td>
<td>What it says to society</td>
</tr>
</tbody>
</table>

Sources: Axsen and Kurani (2012), *Environment and Planning A*
Axsen, Orlebar & Skippon (2013), *Ecological Economics*
4) From interviews to surveys

“Qualitative” interviews
n = dozens

“Quantitative” surveys
n = 100s or 1000s

Technology adoption models
(0-15 year time horizon)

Energy-economy system models
(20-40yr + time horizon)

The “Reflexive Participant” Approach to surveys
Perspectives on the “mainstream” consumer

The “Rational Actor”…..

…has perfect information.
…has established preferences.
…has static preferences.
…can articulate those preferences.

The “Reflexive Participant”…

…might have little or no information
…might have unformed preferences
…can change preferences over time.
…might have trouble communicating those preferences

The respondent:

awareness, understanding, perceptions, preferences

Method:

Survey, interview, model, analysis

Representation of respondent

Results, interpretation, insights
### The “Reflexive Participant” Approach

#### Flow of the conversation

<table>
<thead>
<tr>
<th>Background</th>
<th>Tell me about your car</th>
<th>Inventory/narrative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness</td>
<td>Have you heard of this tech?</td>
<td>“Test” questions</td>
</tr>
<tr>
<td>Initial perceptions</td>
<td>What do you think?</td>
<td>Belief questions</td>
</tr>
<tr>
<td>Explain more</td>
<td>Let me explain more</td>
<td>“Buyers’ Guide”</td>
</tr>
<tr>
<td>Reflexive experience</td>
<td>Go do something</td>
<td>Driving diary/demo</td>
</tr>
<tr>
<td>Response exercise</td>
<td>What would you like in… Context A, Context B, etc.</td>
<td>Design space</td>
</tr>
<tr>
<td>Follow up</td>
<td>Why did you select that?</td>
<td>Belief questions</td>
</tr>
</tbody>
</table>
Canadian “Mainstream” Survey (n = 1754), representative of new vehicle buying households

Part 1
Web-Based
- Current vehicle fleet
- Current electricity use
- Vehicle parking conditions
- Lifestyle preferences
- Attitudes
- Technology awareness

Part 2
Mail & Web-Based
- Home recharge assessment
- 3-Day driving diary
- Buyers guide information booklet: Introduction to vehicle technologies, renewables and vehicle charging

Part 3
Web-Based
- Vehicle Preferences
  Options for different vehicle types:
  - Discrete choice experiments
  - Design space exercises (higher and lower price options)

Green Elec. and Charging Preferences
Options for powering home and vehicle:
- Discrete choice experiments
- Design space exercises (higher and lower price options)

Interviews
In-person
- Vehicle ownership history
- Perspectives of PEVs, renewables and utility controlled charging
- Lifestyles and interest

Source: Axsen et al. (2015), Electrifying Vehicles
## “Design Space” Exercise

Click [Here](#) to open the example response that we provide earlier in a new window.

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Driving range</th>
<th>Gasoline fuel use</th>
<th>Refuel/ Home recharge time</th>
<th>Purchase price</th>
<th>I CHOOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A conventional RAM 1500 4X4 FFV</td>
<td>750 km gasoline</td>
<td>15.2 L/100 km</td>
<td>5 mins</td>
<td>$50000</td>
<td>Conventional</td>
</tr>
<tr>
<td>A hybrid RAM 1500 4X4 FFV</td>
<td>750 km gasoline</td>
<td>10.2 L/100 km</td>
<td>5 mins</td>
<td>$51600</td>
<td>Hybrid</td>
</tr>
<tr>
<td>A plug-in hybrid RAM 1500 4X4 FFV</td>
<td>Electric for the first: Please select your answer</td>
<td>10.2 L/100 km</td>
<td>Time to fully charge empty battery at home Please select your answer</td>
<td>$0</td>
<td>Plug-in hybrid</td>
</tr>
<tr>
<td>A electric only RAM 1500 4X4 FFV</td>
<td>Electric only for: Please select your answer</td>
<td>None</td>
<td>Time to fully charge empty battery at home Please select your answer</td>
<td>$0</td>
<td>Electric</td>
</tr>
<tr>
<td>A hydrogen fuel cell RAM 1500 4X4 FFV</td>
<td>500 km hydrogen</td>
<td>None</td>
<td>5 mins</td>
<td>$61000</td>
<td>Hydrogen</td>
</tr>
</tbody>
</table>

Please select your answer for each vehicle type to choose the most suitable one based on your needs.
Mainstream buyers are more attracted to PHEVs, not so much BEVs

Source: Axsen, Goldberg and Bailey (2016), Transportation Research Part D
## Stated choice experiment

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Range</th>
<th>Recharge/refuel time</th>
<th>Destination recharging or refuelling access</th>
<th>Fuel cost</th>
<th>Purchase price &amp; incentive</th>
<th>I CHOOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Honda CIVIC</td>
<td>650 km gasoline</td>
<td>5 min.</td>
<td>Level 2</td>
<td>$32</td>
<td>$25,000</td>
<td>$0</td>
</tr>
<tr>
<td>Hybrid Honda CIVIC</td>
<td>1070 km gasoline</td>
<td>5 min.</td>
<td>Level 2</td>
<td>$20</td>
<td>$26,380</td>
<td>$0</td>
</tr>
<tr>
<td>Plug-in hybrid Honda CIVIC</td>
<td>575 km First 72 km electric</td>
<td>5 min.</td>
<td>25% of destinations</td>
<td>$18</td>
<td>$30,180</td>
<td>$5,000</td>
</tr>
<tr>
<td>Electric Only Honda CIVIC</td>
<td>200 km electric</td>
<td>5 min.</td>
<td>25% of destinations</td>
<td>$10</td>
<td>$38,820</td>
<td>$5,000</td>
</tr>
<tr>
<td>Hydrogen fuel cell Honda CIVIC</td>
<td>350 km hydrogen</td>
<td>5 min.</td>
<td>20% of gas stations</td>
<td>$10</td>
<td>$41,230</td>
<td>$0</td>
</tr>
</tbody>
</table>

- Conventional
- Hybrid
- Plug-in Hybrid
- Electric
- Hydrogen

Click [HERE](#) to access the Vehicle Buyers' Guide.
## Latent-class choice model (LCM)

**TABLE 5 Results for 5-Segment Latent Class Model (Canadian-wide sample, n=2124)**

<table>
<thead>
<tr>
<th>Segment name</th>
<th>CV-oriented</th>
<th>HEV-oriented</th>
<th>PHEV-oriented</th>
<th>ZEV-curious</th>
<th>PEV-enthusiast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of respondents in segment</td>
<td>23%</td>
<td>21%</td>
<td>22%</td>
<td>21%</td>
<td>13%</td>
</tr>
<tr>
<td>Latent Class Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure of vehicle interest (s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEV</td>
<td>-2.87 ***</td>
<td>1.48 *</td>
<td>1.30 ***</td>
<td>0.653 *</td>
<td>1.07 *</td>
</tr>
<tr>
<td>PHEV</td>
<td>-4.92 ***</td>
<td>-1.47 ***</td>
<td>0.567 **</td>
<td>-0.603 **</td>
<td>2.63 *</td>
</tr>
<tr>
<td>BEV</td>
<td>-8.93 ***</td>
<td>-5.32 ***</td>
<td>-2.90 ***</td>
<td>0.0782</td>
<td>1.89 *</td>
</tr>
<tr>
<td>HFCV</td>
<td>-4.94 ***</td>
<td>-4.19 ***</td>
<td>-2.39 ***</td>
<td>0.0842</td>
<td>-1.11</td>
</tr>
<tr>
<td>Measure of preferences (coefficients)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHEV range (km)</td>
<td>0.001450</td>
<td>-0.000832</td>
<td>0.00263</td>
<td>0.00350 *</td>
<td>0.000578</td>
</tr>
<tr>
<td>BEV range (km)</td>
<td>0.00598</td>
<td>0.00513</td>
<td>0.00265</td>
<td>-0.00277 ***</td>
<td>0.00101</td>
</tr>
<tr>
<td>HFCV range (km)</td>
<td>0.00252</td>
<td>0.00227</td>
<td>0.00220 **</td>
<td>0.000335</td>
<td>0.00150</td>
</tr>
<tr>
<td>Vehicle price (CADS)</td>
<td>-0.000154 ***</td>
<td>-0.000292 ***</td>
<td>-0.000290 ***</td>
<td>-0.000032 ***</td>
<td>-0.000012 ***</td>
</tr>
<tr>
<td>Fuel cost (CADS/week)</td>
<td>-0.000129 ***</td>
<td>0.000133 *</td>
<td>-0.0160 ***</td>
<td>0.000069</td>
<td>-0.000105</td>
</tr>
<tr>
<td>Incentive value (CADS)</td>
<td>0.00129 ***</td>
<td>0.000133 *</td>
<td>0.000296 ***</td>
<td>0.000079 *</td>
<td>0.000096 ***</td>
</tr>
<tr>
<td>Home charging (Level 1 or 2)</td>
<td>0.00120</td>
<td>0.00065</td>
<td>0.00260</td>
<td>0.00425</td>
<td>0.00194</td>
</tr>
<tr>
<td>Workplace charging (Level 1 or 2)</td>
<td>0.0080</td>
<td>0.077</td>
<td>0.034</td>
<td>0.022</td>
<td>0.0011</td>
</tr>
<tr>
<td>Public charging (% of destinations)</td>
<td>0.0120</td>
<td>0.00565</td>
<td>0.00260</td>
<td>0.00425</td>
<td>0.00194</td>
</tr>
<tr>
<td>DC fast charging (access on major highways)</td>
<td>0.0171</td>
<td>0.0205</td>
<td>0.0156 **</td>
<td>0.00121</td>
<td>0.011</td>
</tr>
<tr>
<td>Hydrogen station availability (% of gas stations)</td>
<td>0.0171</td>
<td>0.0205</td>
<td>0.0156 **</td>
<td>0.00121</td>
<td>0.011</td>
</tr>
<tr>
<td>Implied willingness-to-pay (CAD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valuation of vehicle type ($ CAD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEV (all else held constant)</td>
<td>$ (18,675)</td>
<td>$ 5,052</td>
<td>$ 4,476</td>
<td>$ 20,598</td>
<td>$ 87,981</td>
</tr>
<tr>
<td>PHEV-60km (all else held constant)</td>
<td>$ (31,977)</td>
<td>$ (5,028)</td>
<td>$ 1,951</td>
<td>$ (12,396)</td>
<td>$ 215,907</td>
</tr>
<tr>
<td>+ home charging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ DC fast charging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEV-220km (all else held constant)</td>
<td>$ (58,104)</td>
<td>$ (18,188)</td>
<td>$ (9,305)</td>
<td></td>
<td>$ 154,796</td>
</tr>
<tr>
<td>+ home charging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ DC fast charging</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFCV-500km (all else held constant)</td>
<td>$ (32,107)</td>
<td>$ (14,335)</td>
<td>$ (4,443)</td>
<td></td>
<td>$ 543</td>
</tr>
<tr>
<td>+ 10% gas stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ 50% gas stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ 100% gas stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valuation of vehicle type ($ CAD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHEV range (per km)</td>
<td>$ 110</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEV range (per km)</td>
<td>$ (87)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HFCV range (per km)</td>
<td>$ -8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel cost savings (per year)</td>
<td>$ 2,373</td>
<td>$ 2,876</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incentive value (per $1000 incentive)</td>
<td>$ 838</td>
<td>$ 454</td>
<td>$ 1,019</td>
<td>$ 2,494</td>
<td>$ 7,897</td>
</tr>
<tr>
<td>Home charging (of Level 1 or 2)</td>
<td>$ 2,237</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workplace charging (of Level 1 or 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public charging (per % of destinations)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC fast charging (for access on major highways)</td>
<td>$ 1,082</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen stations (per % of gas stations)</td>
<td>$ 54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Segmenting respondents by PEV preference

Class 5: “PEV-enthusiast” 13%
- (+) HEVs
- (++) PHEVs
- (-) BEVs
- Not sensitive to attributes
- Enviro lifestyle

Class 1: “Coventional-oriented” 18%
- (-) HEVs
- (-) BEVs

Class 4: “ZEV-curious” 21%
- (+) HEVs
- (+/-) BEVs
- Fuel cost sensitive
- Sensitive to: fuel cost, fuel/charge available
- Enviro lifestyle

Class 3: “PHEV-oriented” 22%
- (+) HEVs
- (+) PHEVs
- (-) BEVs
- (+/-) HFCVs
- Fuel cost sensitive
- Sensitive to: fuel cost, fuel/charge available
- Enviro concerned

Class 2: “HEV-oriented” 21%
- (+) HEVs
- (+/-) BEV
- Enviro lifestyle

Class 5: “PEV-enthusiast” 13%
- (+) HEVs
- (++) PHEVs
- (-) BEVs
- Not sensitive to attributes
- Enviro lifestyle

21%
5) From surveys to models

“Qualitative” interviews
n = dozens

“Quantitative” surveys
n = 100s or 1000s

Technology adoption models
(0-15 year time horizon)

Energy-economy system models
(20-40yr + time horizon)

“Respondent-based modeling”
The respondent-based preference and constraint model (REPAC)

Constrained Demand + Unconstrained Demand = Home charging \times PEV familiarity \times PEV availability

- Dealership availability
- Class availability

Source: Wolinetz & Axsen (2017), Technological Forecasting & Social Change
The respondent-based preference and constraint model (REPAC)

Constrained Demand \(=\) Unconstrained Demand \(\times\) Home charging \(\times\) PEV familiarity \(\times\) PEV availability

Feedbacks: As sales increase...
...consumer awareness increases
...dealership availability increases
Latent demand and barriers to PEV sales

- Unconstrained demand (UD) for PEV's
- Constrained only by Home charging access (HC)
- Constrained only by PEV Familiarity (PF)
- Constrained only by PEV availability (PA)
- Constrained demand (CD), with PF+HC+PA

Constrained PEV demand without policies: 0.9% in 2015

% PEV new-market share in British Columbia, 2015

Source: Wolinetz & Axsen (2017), Technological Forecasting & Social Change
Comparing PEV policies

Demand-focused policy
- Purchase incentives
- Non-monetary incentives (HOV lane, etc.)
- Charger deployment

Supply-focused policy
- ZEV mandate (sale requirements)
- Fuel efficiency standards
- Low-carbon fuel standards

Adapted from: Axsen et al. (2017), Energy Policy
“Weaker” demand-focused policies might get us to 1% to 10% new market share…

Source: Wolinetz & Axsen (2017), Technological Forecasting & Social Change
Continuing aggressive incentives and charger deployment could get up to ~20% by 2030

Source: Wolinetz & Axsen (2017), Technological Forecasting & Social Change
“Full” PEV supply needed to get up to 30% or higher

Source: Wolinetz & Axsen (2017), Technological Forecasting & Social Change
Multiple ways to push electric vehicles, but subsidies cost* 20-30 times more than ZEV mandate

Both can achieve 30% PEV new market share by 2030

Source: Axsen and Wolinetz (Under review), *Energy Policy*

*Gov’t Spending on PEV subsidies (millions, undiscounted)
6) From research to policy evaluation

“Qualitative” interviews
n = dozens

“Quantitative” surveys
n = 100s or 1000s

Technology adoption models
(0-15 year time horizon)

Energy-economy system models
(20-40yr + time horizon)

Policy evaluation
Canada's Electric Vehicle Policy Report Card

Dr. Jonn Axsen
Suzanne Goldberg
Noel Melton

Sustainable Transportation Action Research Team
Simon Fraser University
November 2016

Evaluating plug-in electric vehicle policies in the context of long-term greenhouse gas reduction goals: Comparing 10 Canadian provinces using the “PEV policy report card”

Noel Melton\textsuperscript{a,h}, Jonn Axsen\textsuperscript{b}, Suzanne Goldberg\textsuperscript{b}
Policy Goal:
To achieve long-term GHG mitigation targets, PEVs reach 40% of new vehicle market share by 2040 (IEA scenario) – that is an “A”

1. Identify electric vehicle supportive policies
2. Evaluate the effectiveness of each policy
3. Assign letter grades to each province (based on the effectiveness of their policies)

Adapted from: Axsen et al. (2017), Energy Policy
Grades across Canada…. 7 provinces in the “D” or “F” range

Adapted from: Axsen et al. (2017), Energy Policy
Grades across Canada…. Ontario and BC in the “C” range

Adapted from: Axsen et al. (2017), *Energy Policy*
Grades across Canada…. Quebec is our inspiration at “B”

Adapted from: Axsen et al. (2017), Energy Policy
What are the most effective climate policies in Canada?

- ZEV mandate
- Incentive
- Carbon pricing

Adapted from: Axsen et al. (2017), Energy Policy
# World-leading policy can raise all grades

<table>
<thead>
<tr>
<th>Province</th>
<th>Current policies*</th>
<th>Current + proposed*</th>
<th>Current + proposed*  + “Norway-like”</th>
<th>Current + proposed* + “California-like”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>C−</td>
<td>C</td>
<td>B+</td>
<td>B+</td>
</tr>
<tr>
<td>British Columbia</td>
<td>C−</td>
<td>C−</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
<td>Alberta</td>
<td>D</td>
<td>D</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>F</td>
<td>D</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
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<td>D</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
<td>Ontario</td>
<td>C−</td>
<td>C</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
<td>Quebec</td>
<td>B−</td>
<td>B</td>
<td>A</td>
<td>B+</td>
</tr>
<tr>
<td>New Brunswick</td>
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<td>D</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
<td>Nova Scotia</td>
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<tr>
<td>Prince Edward Island</td>
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<td>D</td>
<td>B</td>
<td>B+</td>
</tr>
<tr>
<td>Newfoundland and Labrador</td>
<td>F</td>
<td>D</td>
<td>B</td>
<td>B+</td>
</tr>
</tbody>
</table>
Methodological conclusions...

“Qualitative” interviews
n = dozens

“Quantitative” surveys
n = 100s or 1000s

Technology adoption models
(0-15 year time horizon)

Energy-economy system models
(20-40yr + time horizon)

Policy evaluation

Missing methods? historical case studies, stakeholder interviews, random experiments
Policy implications

• PEVs can play an important role in GHG mitigation
• “Latent” demand is there – but widespread uptake isn’t likely to happen without policy
• **Strongly policy** needed, likely supply-focused (e.g. ZEV mandate)
• Need improved understanding of supply side
• Other methods, theories