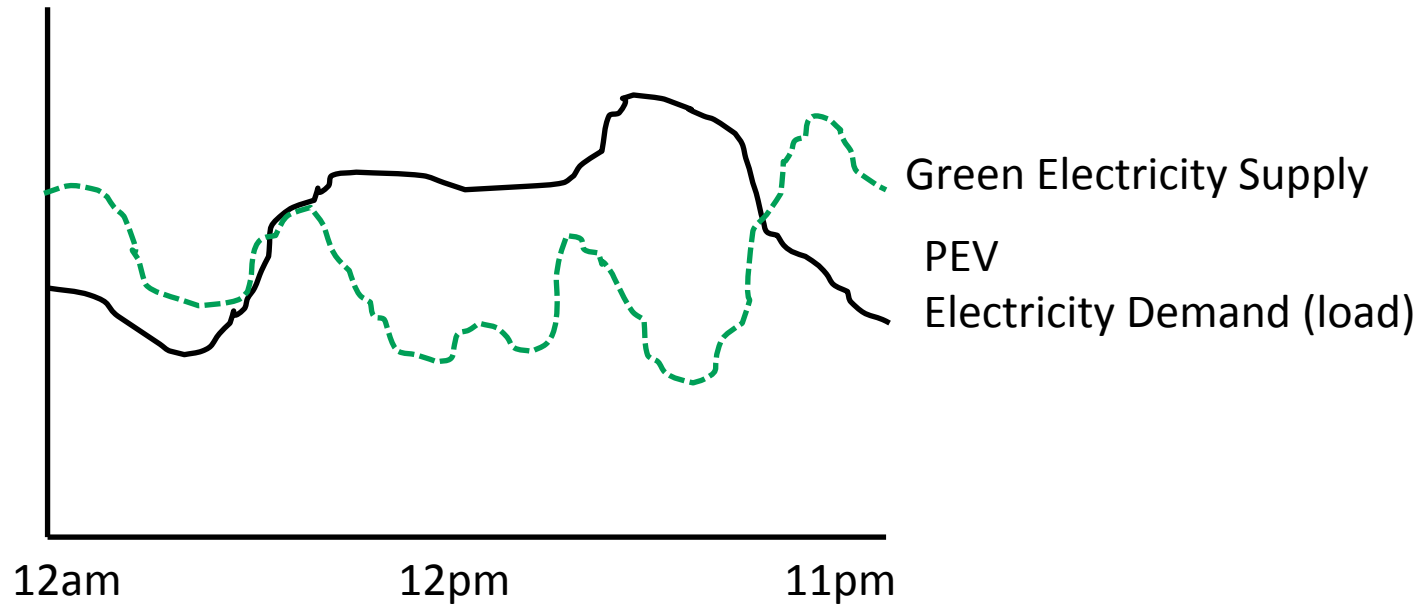


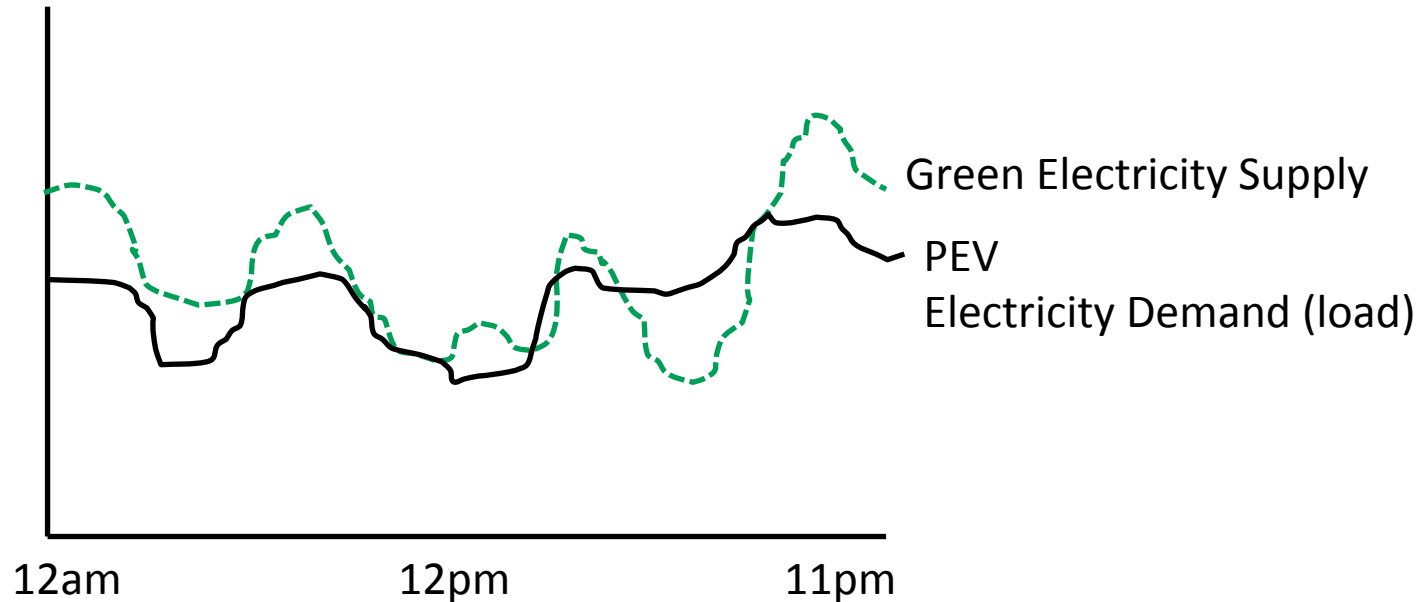
# Pairing renewables & PEVs

- Many sources of renewables are **intermittent** so the timing of electricity supply may not match the timing of electricity demand.



# Pairing renewables & PEVs

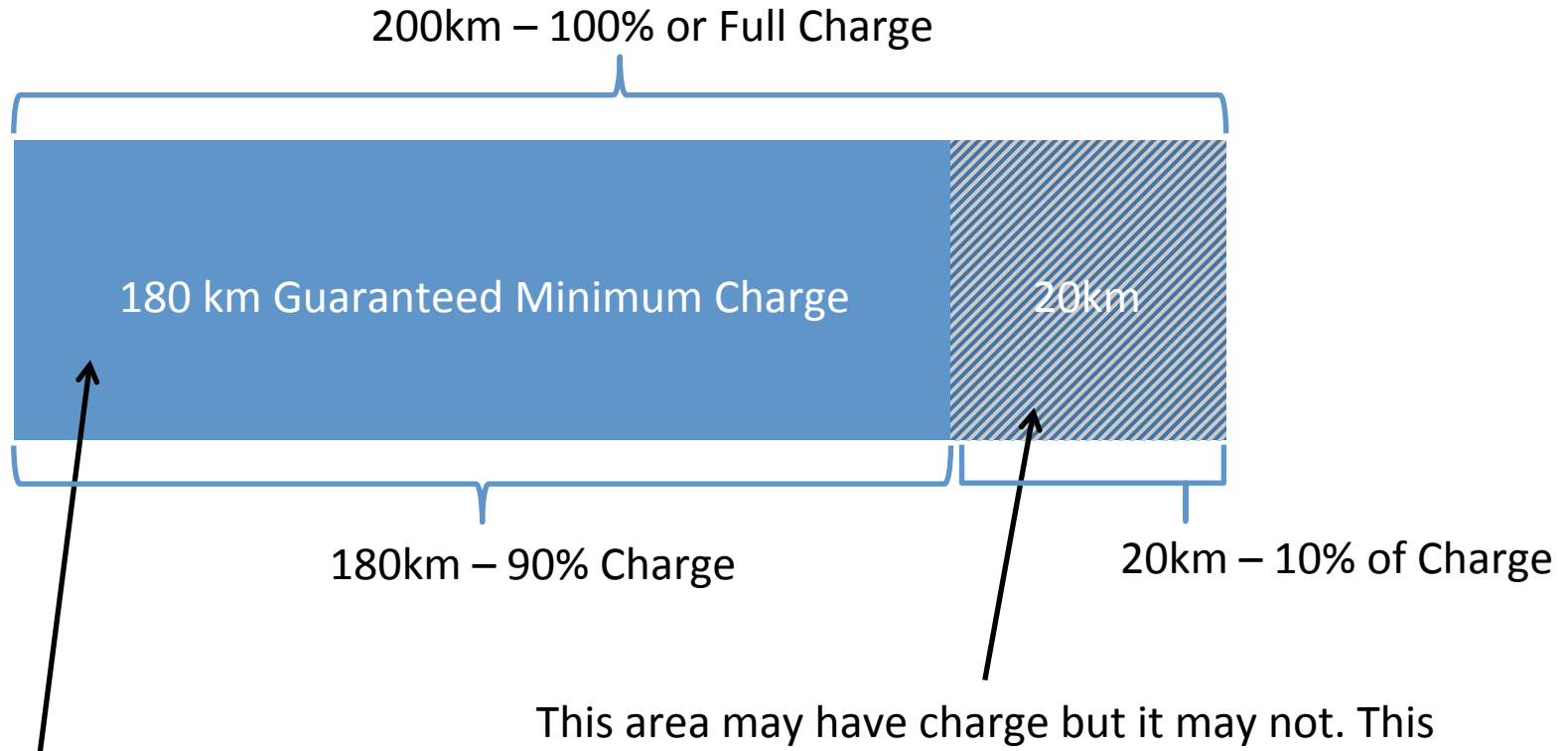
- Many sources of renewables are **intermittent** so the timing of electricity supply may not match the timing of electricity demand.



# Utility Controlled Charging

- **Utility controlled charging (UCC)**—Any situation where the electric utility controls Plug-in Electric Vehicle (PEV) charging in order to better utilize intermittent renewable electricity sources.
- For example control of:
  - when the vehicle begins to charge
  - when the vehicle stops charging
  - vehicle discharging (V2G - potentially long term future?)

# Guaranteed minimum charge (GMC)



The absolute minimal level of charge that you would wake up to on any given morning.

This area may have charge but it may not. This will depend on the utility.

The larger the consumer allows this area to be the more useful their vehicle can be to the utility.

# Research Questions

1. **Who** are the “early mainstream” PEV buyers that might be charging in the near future?
2. What **electricity sources** do they want to charge with?
3. How do they **feel about UCC**?
4. What is **most important** to them? Cost, guaranteed minimum charge or source of electricity supply?

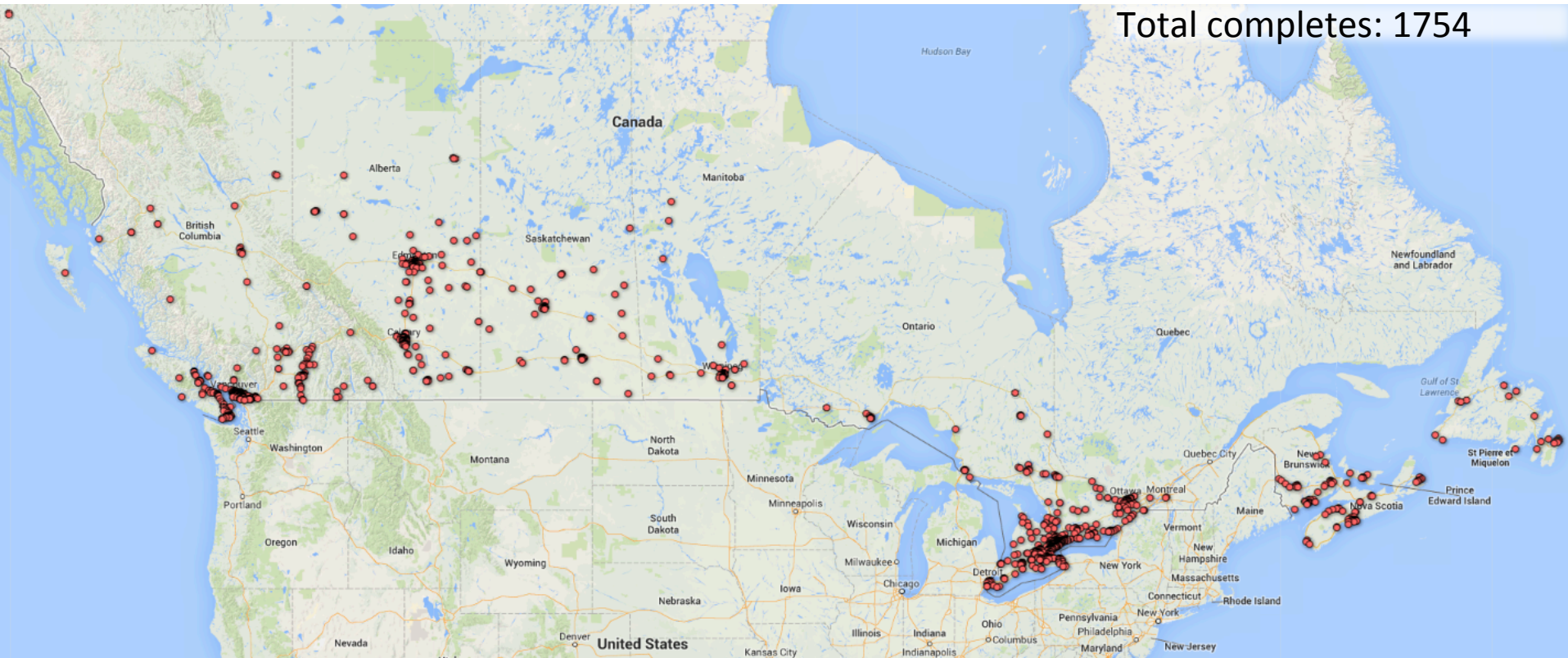
# Our findings...

1. Around 1/3 of Canadian new vehicle buyers express **some interest in owning a PEV** (the “early mainstream”).
2. This “early mainstream” group, would **prefer to charge** their **PEV with renewables** such as solar, wind & run-of-river.
3. The “early mainstream” express concerns over reductions in **privacy** (24%) and personal vehicle **control** (37%) that may arise from UCC.
4. The “early mainstream” are not completely opposed to utility controlled charging but do value cost savings and a full vehicle charge more than renewable electricity.

# Canadian PEV Survey (CPEVS 2013)

- Three-part survey of Canadian new vehicle buyers:
  1. Investigating current household vehicle fleet, electricity supply and general lifestyle / attitudes.
  2. Three-day driving diary used to elicit driving behaviour and recharge availability.
  3. **Identifying preferences for PEVs and UCC using design space exercises and stated preference modeling.**

# The Sample



The overall sample is **generally representative of new car buyers:**

Older, higher income, more highly educated, and more likely to own their own home



# Research Questions

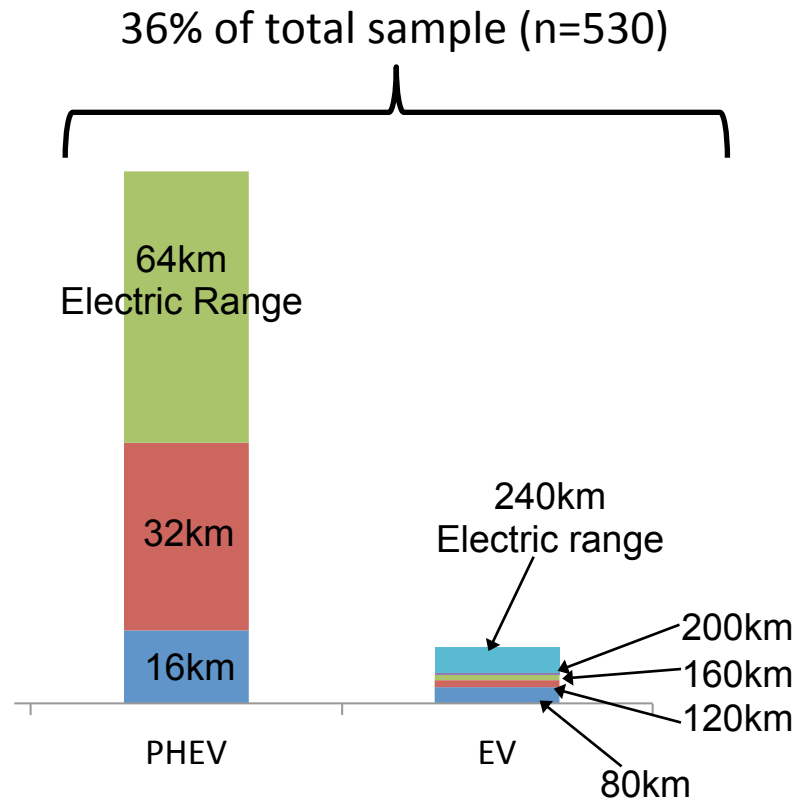
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# The Design Game

# Who are the “early mainstream?”

36% = **potential**  
“early mainstream”  
PEV buyers

Further analysis uses only  
these respondents

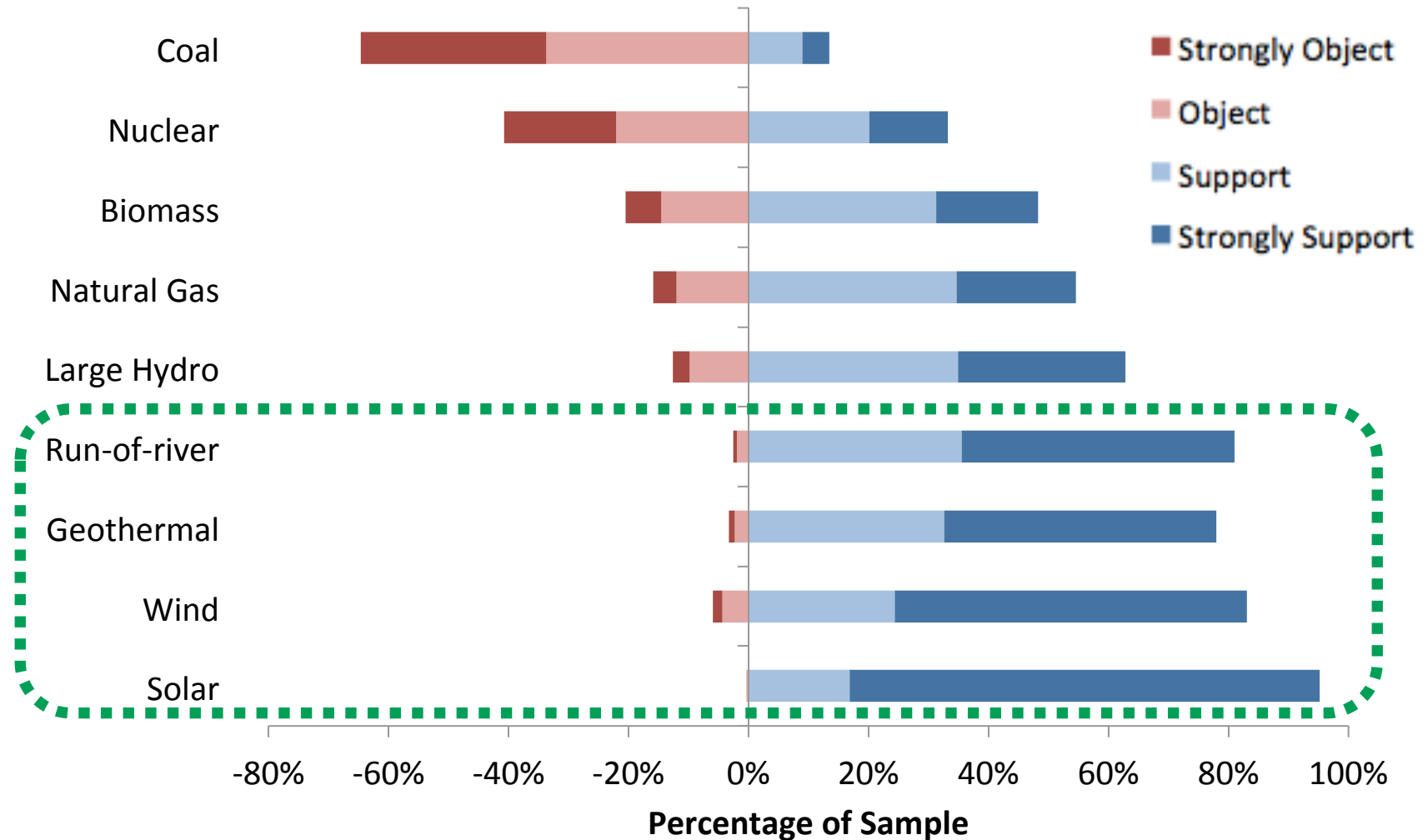


# Research Questions

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4. What is **most important** to them? Cost, guaranteed minimum charge or electricity supply?

# Preferences for electricity source when charging PEVs

How do you feel about using the following energy sources to produce electricity for electric vehicles?



# Research Questions

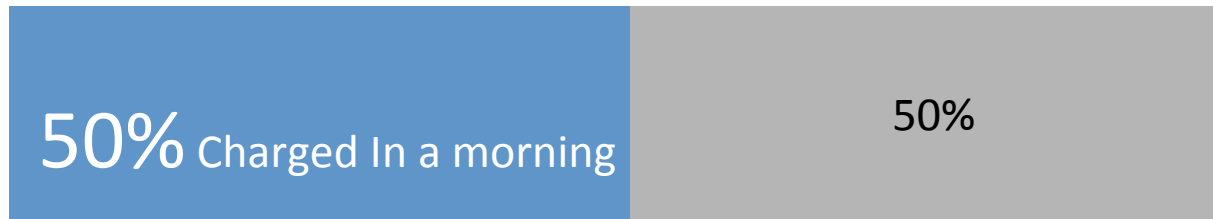
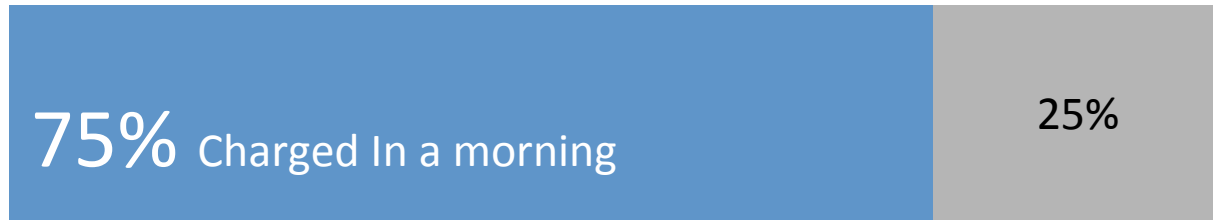
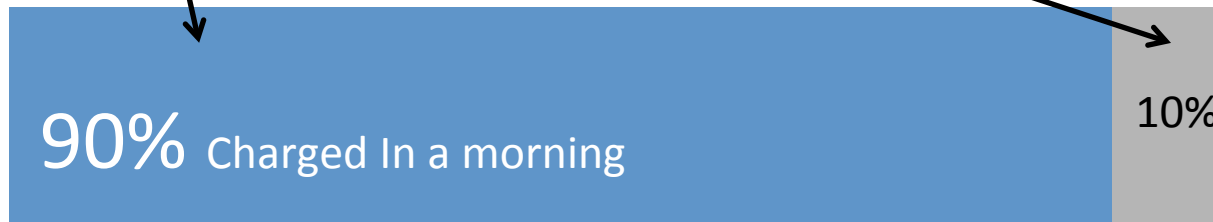
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# Guaranteed Minimum Charge

The absolute minimal level of charge that you would wake up to on any given morning.

Consumer Inconvenience

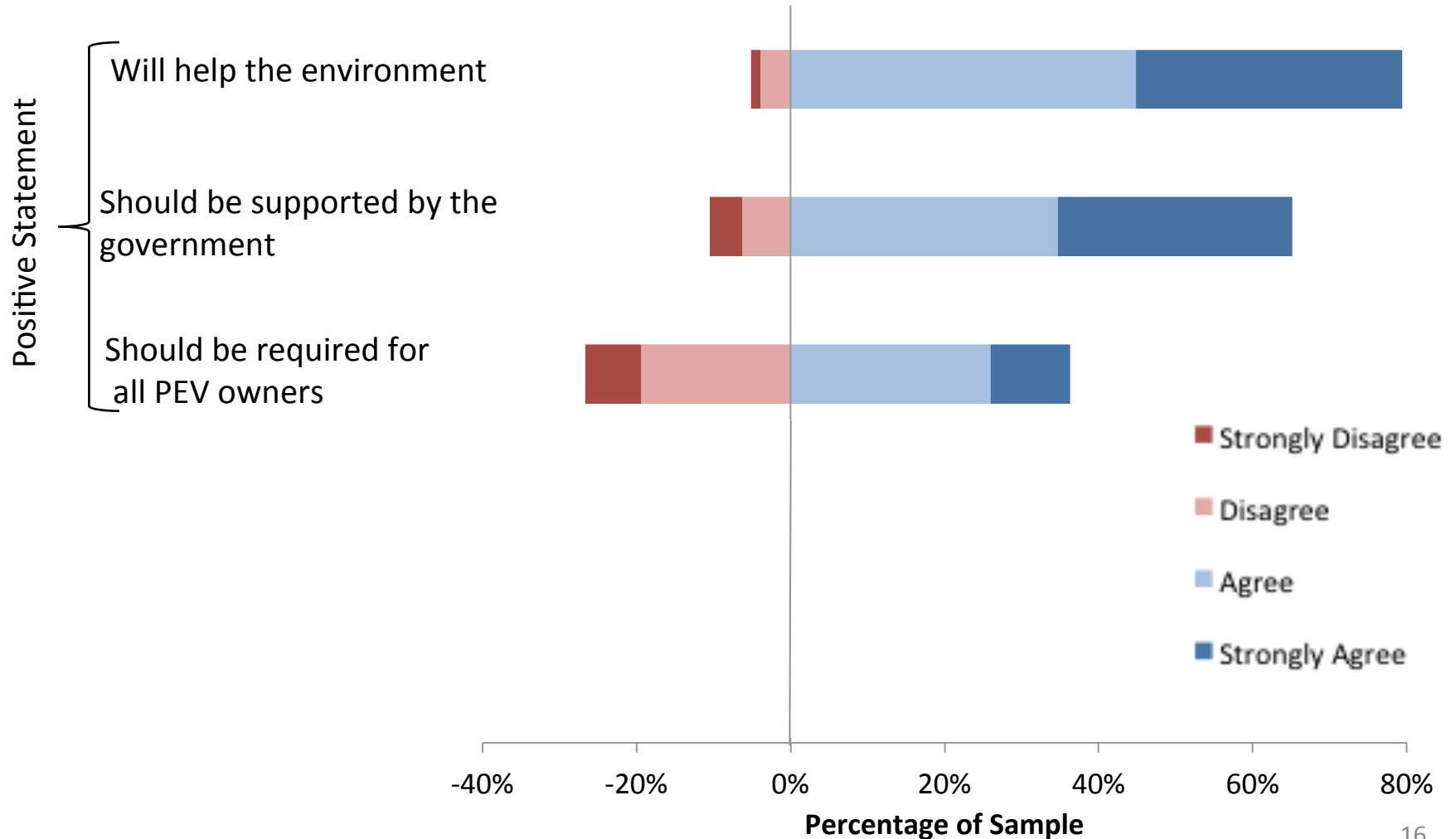
Percentage of respondents that would accept this GMC every day



# How do they feel about UCC?

To what extent do you agree with the following statements about Utility Controlled Charging?

## Utility controlled charging...






# Research Questions


1. **Who** are the “early mainstream” PEV buyers that might be charging in the near future?
2. What **electricity sources** do they want to charge with?
3. How do they **feel about UCC**?
4. What is **most important** to them? Cost, guaranteed minimum charge or electricity supply?

# Making Tradeoffs – Stated Preferences

Status Quo

Charge Style	% of Green Electricity	Source of Green Electricity	Guaranteed Minimum Charge	Monthly Electricity Bill	I CHOOSE
 Your Status Quo	Your Current Mix	Your Current Sources	100% 64 km	\$95 /month	Status Quo <input type="radio"/>

UCC alternative 1

 Charge Style 1	25 % Green Electricity	Small Hydro	100 % 64 km	\$76 /month	Style 1 <input checked="" type="radio"/>
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UCC alternative 2

 Charge Style 2	50 % Green Electricity	Solar	70 % 45 km	\$76 /month	Style 2 <input type="radio"/>
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Next

Click [HERE](#) to download the Buyers' Guide



# When combining the different components of UCC we find out what may drive preferences

On average...

The “early mainstream” respondents are more likely to **prefer UCC if:**

- It is **cheaper**
- It provides **more renewable electricity**
- Respondents are more **highly educated**
- The source of electricity for UCC is **not from wind energy**
- Higher NEP scale show higher interest for renewables

# Different UCC programs

- Around 36%\* of Canadian “early mainstream” respondents may adopt UCC.
- By changing the characteristics of a UCC program, adoption rates may change:

Potential UCC program	Potential Adoption	Change from base adoption
Green Program 1 – 100% Renewables, 100% GMC	48%	+12%
Green Program 2 – 100% Renewables, 80% GMC	40%	+4%
Subsidy Program – 20% Reduced Bill, 80% GMC	43%	+7%

Recall: this is 36% of the “early mainstream”.  
This is approximately 13% of all 1754 respondents.

# To take away...

1. The “early mainstream” would **prefer to charge** their **PEV with renewables**.
2. The “early mainstream” express concerns over reductions in **privacy** (24%) and personal vehicle **control** (37%) that may arise from UCC.
3. The “early mainstream” are not completely opposed to utility controlled charging. They **value cost savings** and a full vehicle charge **more than renewable electricity**.

# Thank you

Thanks to:

Jonn Axsen & George Kamiya  
Paulus Mau, Grace Lau, Steven Groves  
Jeff Rambharack & Curran Crawford  
Testers  
Respondents

## Contact:

Joseph Bailey | Doctoral Candidate  
Energy and Materials Research Group  
Simon Fraser University | [hbailey@sfu.ca](mailto:hbailey@sfu.ca)

# Demographics

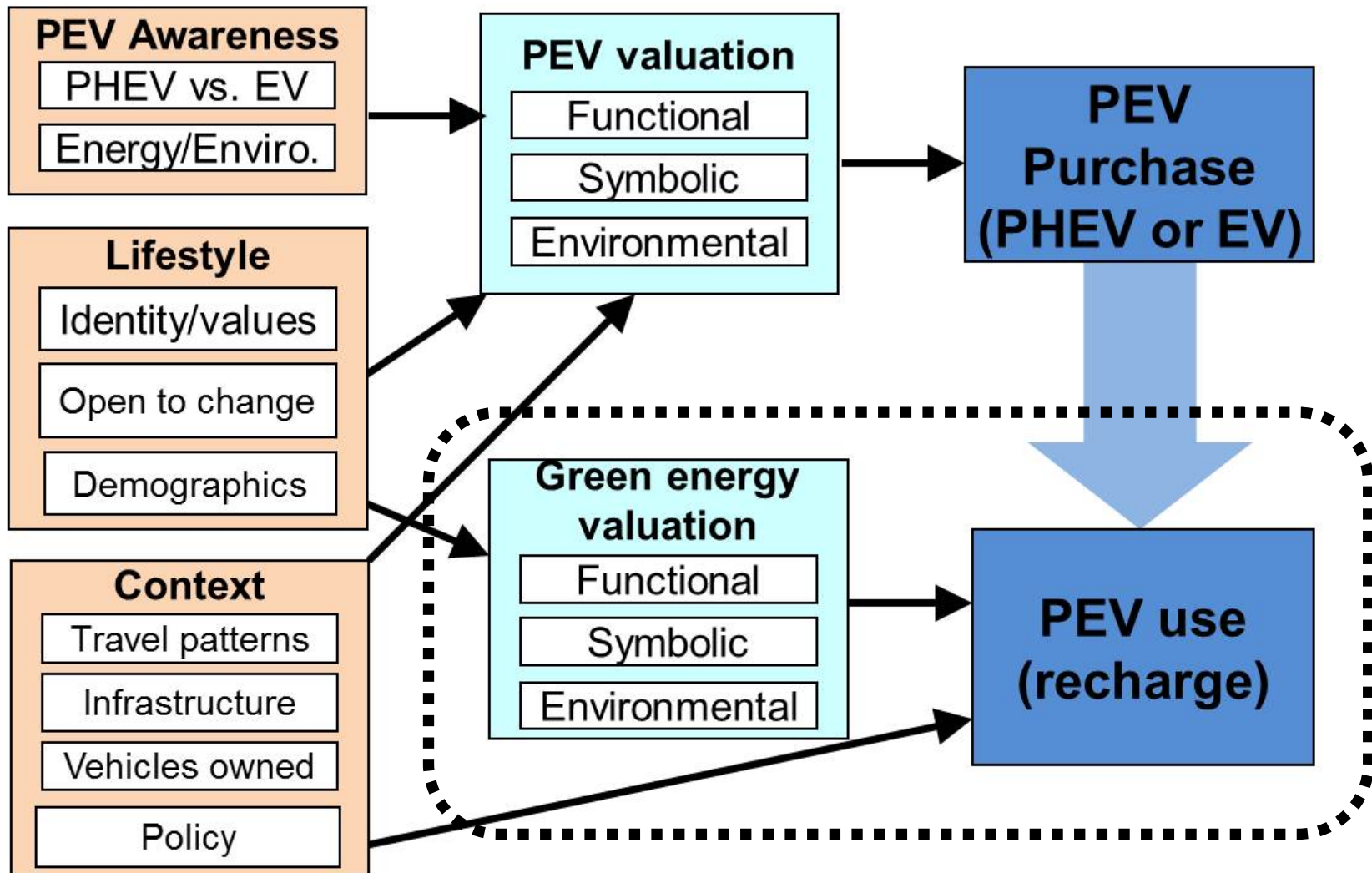
Region	British Columbia		Canada	
	Survey (n = 538)	Census (BC)	Survey <sup>a</sup> (n = 1754)	Census (Canada)
<b>Sample Size</b>	538	4,400,057	1,754	33,476,688
<b>Household Size</b>				
1	15.1%	28.3%	13.1%	27.6%
2	42.2%	34.8%	40.0%	34.1%
3	18.8%	15.0%	20.8%	15.6%
4+	24.0%	22.0%	26.2%	22.7%
<b>Sex</b> (of person filling out the survey)				
Female	60.8%	51.0%	58.4%	51.0%
Male	39.2%	49.0%	41.6%	49.0%
<b>Age</b> (of person filling out the survey)				
15-24	7.1%	12.6%	7.0%	13.0%
25-34	18.8%	12.8%	23.0%	12.9%
35-44	18.8%	13.5%	18.2%	13.4%
45-54	20.4%	16.0%	19.5%	15.9%
55-64	19.5%	14.0%	19.2%	13.1%
65+	15.4%	15.7%	13.1%	14.8%
<b>Work Status</b> (of person filling out the survey)				
Employed	59.1%		60.9%	62.3%
Retired	23.0%		21.0%	
Student	3.7%		4.0%	33.1% <sup>b</sup>
Family caregiver	7.1%		6.8%	0.2%
Presently unemployed	5.9%		5.6%	4.4%
Not applicable	1.1%		1.8%	0.0%
<b>Highest level of education completed</b> (of person filling out the survey)				
Less than high school	2.6%	19.9%	1.8%	23.8%
High school certificate or equivalent	16.7%	27.9%	16.6%	25.5%
Apprenticeship, trades certificate or diploma	9.8%	10.9%	6.2%	10.9%
College, CEGEP, or other non-univ. diploma	21.6%	16.7%	24.3%	17.3%
Some university	12.4%	5.4%	12.5%	4.4%
University degree (Bachelor)	26.5%	14.2%	26.2%	13.5%
Graduate or professional degree	10.5%	5.1%	12.4%	4.6%
<b>Household income</b> (pre-tax)				
Less than \$40,000	16.5%	25.8%	14.8%	24.9%
\$40,000 to \$59,999	21.9%	19.0%	20.5%	19.3%
\$60,000 to \$89,999	28.8%	24.2%	27.8%	24.3%
\$90,000 to \$124,999	23.5%	16.8%	24.6%	16.8%
Greater than \$125,000	9.4%	14.2%	12.2%	14.7%
<b>Residence ownership</b>				
Own	75.8%		77.9%	68.7%
Rent	24.2%		22.1%	31.3%
<b>Residence type</b>				
Detached House	61.7%	53.8%	66.7%	61.9%
Attached House (e.g. townhouse, duplex, triplex, etc.)	14.8%	23.2%	15.3%	17.0%
Apartment – “low-rise” (<5 story’s/levels)	14.6%	15.1%	10.0%	13.2%
Apartment – “high-rise” (≥5 story’s/levels)	6.6%	5.7%	6.4%	6.8%
Mobile Home	2.3%	2.1%	1.6%	1.2%

# Survey Information

- For more information on the CPEVS 2013 survey visit: <http://www.rem.sfu.ca/people/faculty/jaxsen/CPEVS-2013-documents/>

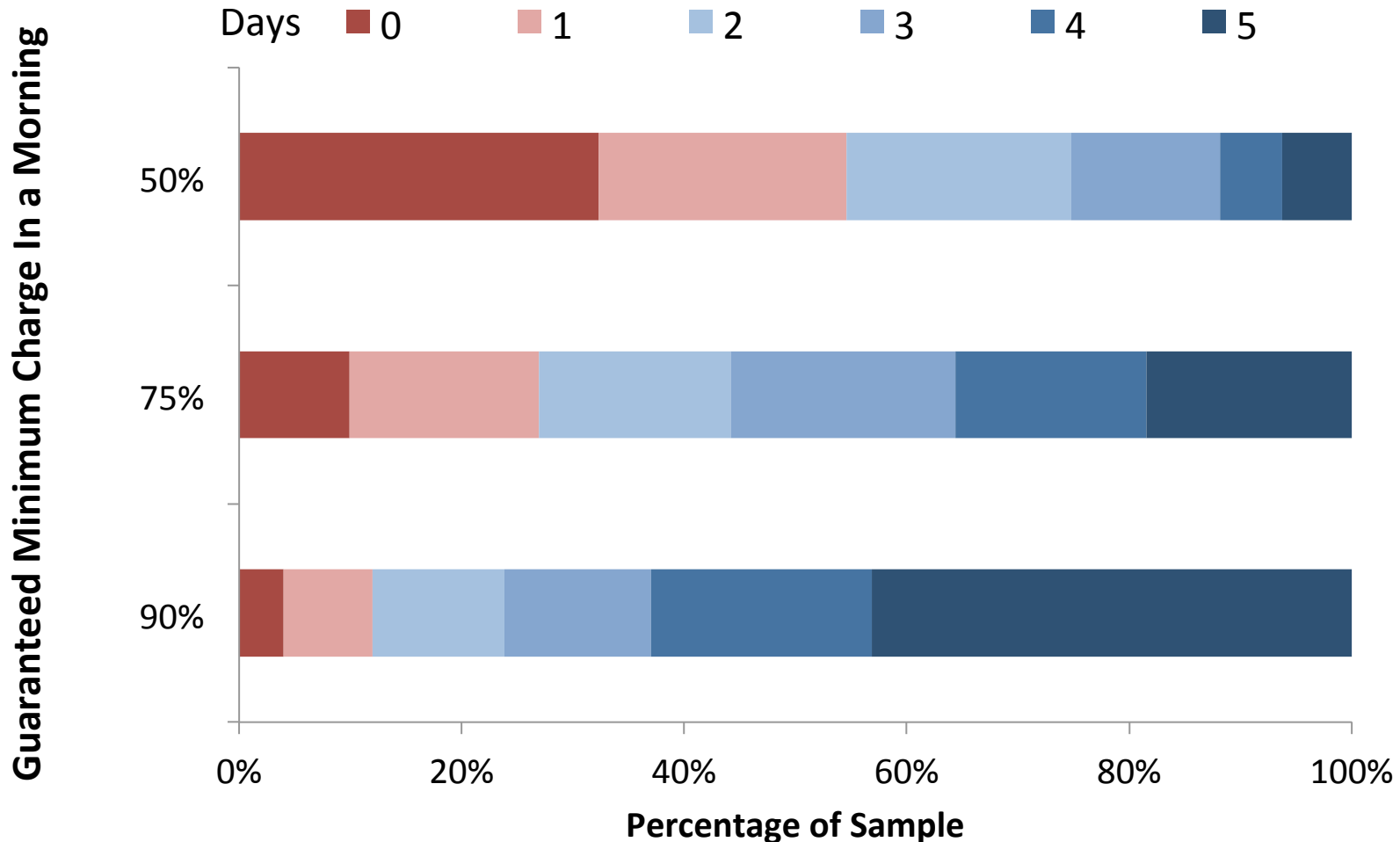


# CPEVS 2013: Conceptual Framework



# Guaranteed Minimum Charge

How frequently (days out of 5) would you be willing to wake up to a vehicle that was only X% charged?



# Level 2 Installation Costs

- Price model for Level 2 installation at all (only for respondents that):
  - have a reliable parking space
  - do not already have Level 2 access
  - have authority to install a vehicle charger)

	Obstacle	Cost
<b>Base cost: distance from parking spot to electricity supply panel</b>	<25 feet	\$1000
	26-50 feet	\$1500
	> 50 feet	\$2000
<b>Additional costs: obstacles</b>	Multiple walls	+\$500
	Paved space	+\$500
	Building floors	+\$500

# Design Game: Upgrade Costs

**Table 1: PEV “Design space” exercise options and prices (prices incremental to respondents’ next anticipated conventional vehicle).**

Vehicle type and battery range (km)	Higher price				Lower price			
	Compact	Sedan	Mid-SUV	Full-SUV	Compact	Sedan	Mid-SUV	Full-SUV
<b>HEV</b>	\$1380	\$1740	\$2050	\$2470	\$930	\$1070	\$1200	\$1370
<b>PHEV-16</b>	\$2230	\$2720	\$3130	\$3690	\$1690	\$1910	\$2100	\$2360
<b>PHEV-32</b>	\$2680	\$3230	\$3810	\$4500	\$1910	\$2170	\$2440	\$2770
<b>PHEV-64</b>	\$3560	\$4260	\$5190	\$6120	\$2350	\$2680	\$3130	\$3580
<b>EV-80</b>	\$6500	\$7880	\$10150	\$12150	\$3220	\$3620	\$4600	\$5300
<b>EV-120</b>	\$8940	\$10690	\$13930	\$16600	\$4440	\$5030	\$6490	\$7520
<b>EV-160</b>	\$11380	\$13500	\$17710	\$21050	\$5660	\$6440	\$8380	\$9750
<b>EV-200</b>	\$13820	\$16310	\$21490	\$25500	\$6880	\$7840	\$10270	\$11970
<b>EV-240</b>	\$16260	\$19130	\$25260	\$29940	\$8100	\$9250	\$12160	\$14200

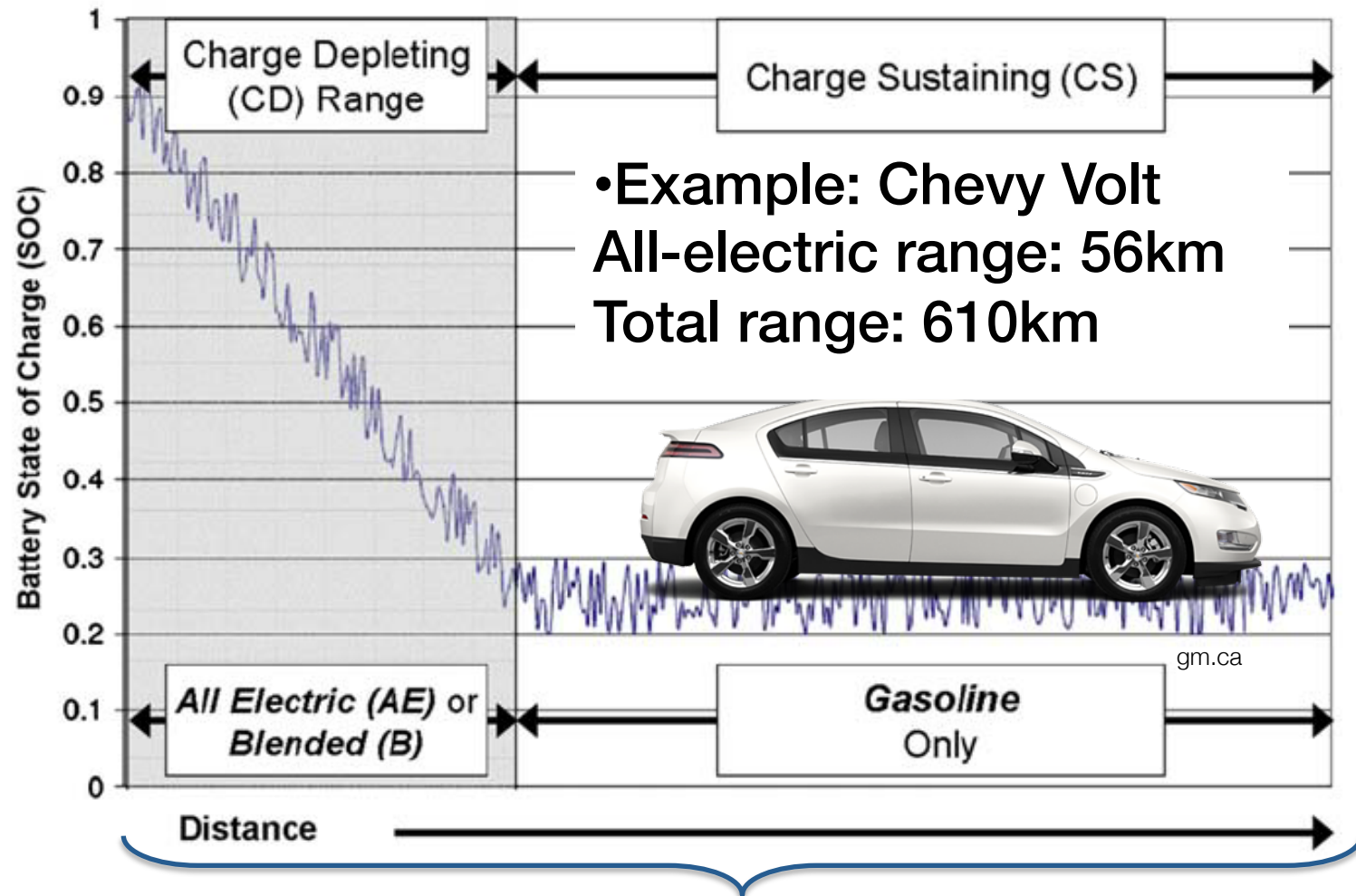
# Vehicle Assumptions

- Usable battery capacity (kWh) for a range of PEV designs and vehicle classes (Adapted from Axsen and Kurani, 2013b)

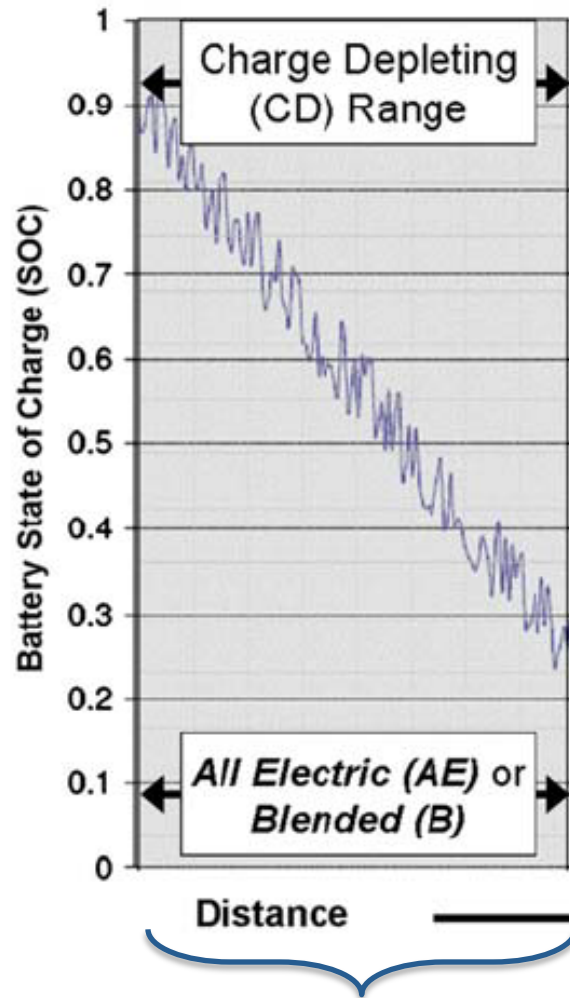
	Usable Battery Capacity (kWh)			
	Compact	Sedan	Mid-SUV	Full-SUV
PHEV-16	2.6	3.0	4.0	4.7
PHEV-32	5.2	6.0	8.1	9.5
PHEV-64	10.4	12.0	16.1	19.0
EV-80	13.0	15.0	20.2	23.7
EV-120	19.5	22.5	30.2	35.6
EV-160	26.0	30.0	40.3	47.4
EV-200	32.5	37.5	50.4	59.3
EV-240	39.0	45.0	60.5	71.2

- Electricity consumption (kWh/km) by vehicle class (Adapted from Axsen and Kurani, 2013b)

Class	Consumption (kWh/km)
Compact	0.163
Sedan	0.188
Mid-SUV	0.252
Full-SUV	0.297



# Plug-in Hybrid Electric Vehicle (PHEV)



- Electric motor only
- Example: Nissan Leaf
- All-electric range: 117km



nissan.ca

## Battery-Electric Vehicle (BEV)