



Developing Methods for VGI Modeling and Value Assessment

Kadir Bedir, PhD. Candidate

Institute of Transportation Studies, UCDavis

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OUTLINE

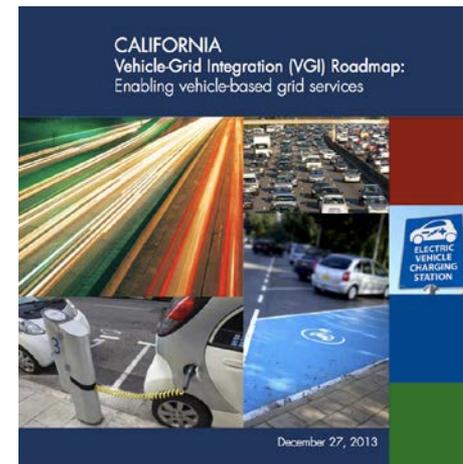
- UCD research on VGI stakeholders
- Review of results: What's VGI and Why VGI?
- VGI alternatives and grid services
- Demonstrating a value assessment model

Acknowledgements:

- All interview participants
- My research advisors: Dr. Joan Ogden, Dr. Mark Lubell, and Dr. Tom Turrentine
- Bill Boyce and Deepak Aswani of SMUD

Policy and Market Developments	Organization	Date
California Senate Bill 626 (Kehoe) is chaptered	CA Senate	February, 2009
Alternative Fuel Vehicle (AFV) Proceeding is introduced	CPUC	January, 2010
AFV Proceeding: Phase-2 is introduced	CPUC	August, 2010
Chevy Volt and Nissan Leaf sales began	GM and Nissan	December, 2010
"Taking Charge" PEV roadmap is released	California PEV Collaborative	December, 2010
Governor's Zero Emission Vehicles (ZEV) Initiative is announced	Governor's Office	March, 2012
ZEV Action Plan is released	Governor's Office	September, 2012
VGI roadmap workshops started	Vehicle-Grid Working Group	October, 2012
Vehicle-Grid Integration Roadmap is released	CAISO	December, 2013

POLICY AND MARKET DEVELOPMENTS IN CALIFORNIA (2009 – 2014)



VGI stakeholder Interviews were conducted between March 2013 and June 2014.

	INTERVIEW PARTICIPANTS	DATE	SECTOR
1	CAISO	3/21/13	Policy
2	Southern California Edison (SCE)	3/25/13	Utility sector
3	San Diego Gas & Electric (SDGE)	3/25/13	Utility sector
4	Sacramento Municipality Utility District (SMUD)	4/3/13	Utility sector
5	ChargePoint	4/4/13	PEV sector
6	Pacific Gas and Electric (PG&E)	4/5/13	Utility sector
7	Nissan Fuel Cell Research Group	4/8/13	PEV sector
8	AeroVironment	4/10/13	PEV sector
9	Ford Vehicle Electrification and Infrastructure	4/12/13	PEV sector
10	Los Angeles Department of Water and Power (LADWP)	4/18/13	Utility sector
11	ECOtality	4/25/13	PEV sector
12	California Public Utilities Commission	11/20/13	Policy
13	Former Senator Christine Kehoe	12/20/13	Policy
14	GM/OnStar Alliance	1/8/14	PEV sector
15	California Energy Commission	4/24/14	Policy
16	Governor's Office	4/30/14	Policy
17	BMW Group Technology Office	6/11/14	PEV sector



What is “vehicle-grid integration”?

- Developing advanced PEV charging control mechanisms to support grid reliability and economic dispatch.

“without interfering consumers’ transportation needs!”



Survey results: How did VGI come into political agenda?

Stakeholders' response:

1. To increase PEV adoptions
2. Economic prospects on grid services
3. To reduce impacts on the grid infrastructure



Survey results: VGI Configurations as discussed by stakeholders

1. Metering: single meter vs separate meter
2. Power flow: V2G vs V1G
3. Communication: networked vs standalone
4. Management: aggregated vs fragmented



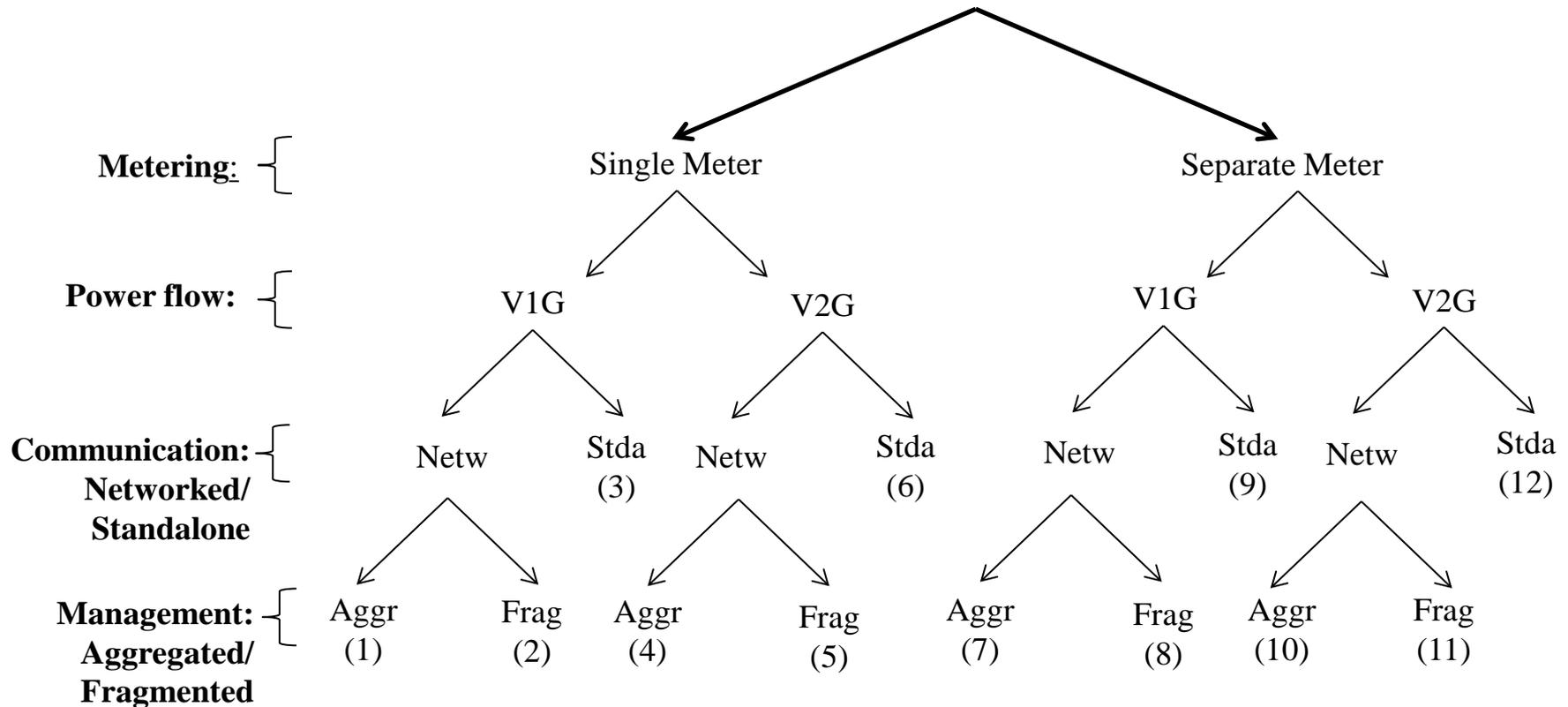
Survey results: PEV-based grid services discussed by stakeholders

1. Demand side management (DSM):
 - Household TOU; PEV-TOU; RTP
2. Demand response (DR) programs:
 - Residential; wholesale market
3. Frequency regulation
 1. Energy Storage:
 - V2G; V2H

Conclusions from Stakeholder Analysis

1. Largest barrier toward a VGI solution is the complexity of value assessment of the alternatives
1. Solutions will be regional
1. Dialogue among stakeholders and sharing experiences through feedback channels are crucial

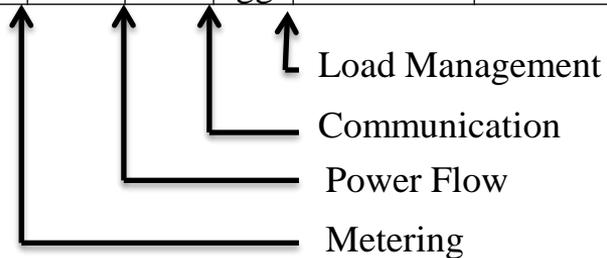
VGI alternatives:



12 different alternatives!

Alternatives vs Services Table:

				DSM PEV household	DSM PEV-only	DSM PEV- RTP	Residential DR	Wholesale DR	Frequency regulation	Energy storage residential (V2H)	Energy storage wholesale (V2G)
1	(s)meter	V1G	stda	✓							
2	(s)meter	V1G	netw frag	✓		✓	✓				
3	(s)meter	V1G	netw aggr	✓		✓	✓	✓	✓		
4	(s)meter	V2G	stda	✓						✓	
5	(s)meter	V2G	netw frag	✓		✓	✓			✓	
6	(s)meter	V2G	netw aggr	✓		✓	✓	✓	✓	✓	✓
7	sep.meter	V1G	stda	✓	✓						
8	sep.meter	V1G	netw frag	✓	✓	✓	✓				
9	sep.meter	V1G	netw aggr	✓	✓	✓	✓	✓	✓		
10	sep.meter	V2G	stda	✓	✓					✓	
11	sep.meter	V2G	netw frag	✓	✓	✓	✓			✓	
12	sep.meter	V2G	netw aggr	✓	✓	✓	✓	✓	✓	✓	✓





Demonstrating model in Sacramento County

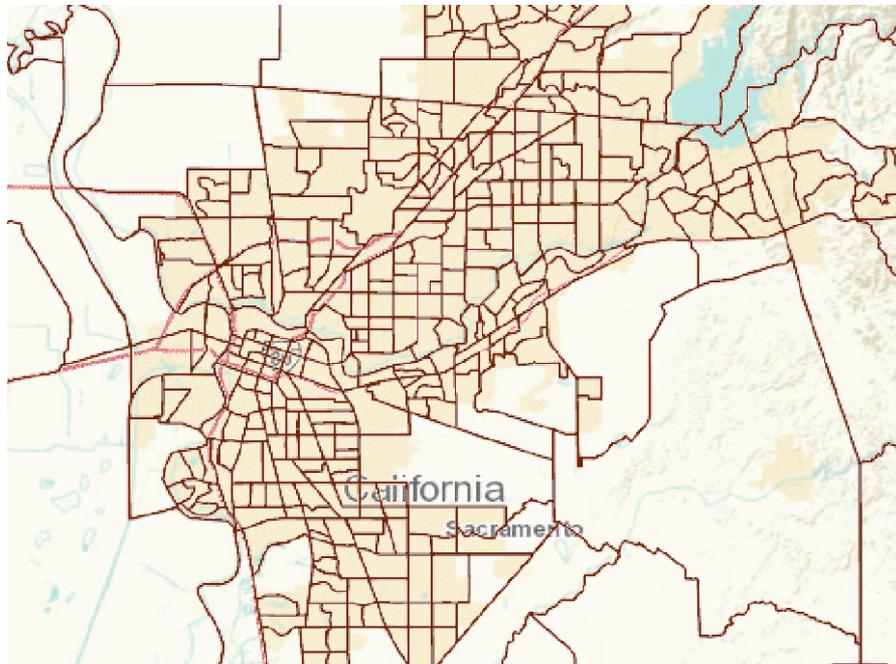
Considering California's 1.5 million ZEV adoption goal, Sacramento County's share will be around 61,665 (corresponds to 12% PEV adoption).





Performing analysis: semi-random PEV deployment

Using tract level vehicle ownership data from American Community Survey 2013



Number of households having two or more vehicles correlates 88% with number of households having a detached unit; 91% with number of households commute by car; and 73% with number of high income (\$100K and over) households.



Performing analysis: PEV Buyers' Optimization Problem

- Objective: find the cheapest and quickest charging schedule, which also satisfies drivers' individual constraints.
- Constraints: energy needs (based on commute distance), and driver's commute hours.
- Decision variable: charge start time
- Time domain: 30m time intervals (48 time slots)

Economic implications of the expected outcomes:

	Utility Company	PEV Buyer
Avoided distribution upgrades	Benefit	N/A
Avoided generation capacity costs	Benefit	N/A
Communication infrastructure cost	Cost	Cost
Electricity rate/Revenue increases	Benefit	Cost
Electricity rate/Revenue reductions	Cost	Benefit
Incentives paid to PEV buyers	Cost	Benefit

- To be completed by July 2015.



Questions...

