

‘Big Data’ in Personal Transportation  
- for product planning, product design, policy analysis ...  
- for real-time system management

Mike Tamor  
Henry Ford Technical Fellow, Energy  
Systems & Sustainability  
Ford Motor Company



# Big Data – According to Mike

Masses of Data

- large sample size
- longitudinal

Diversity  
of  
Sources

Well Formed Questions

It Helps to Know What You are Looking For



Analyze  
Abstract  
Merge



Robust, Actionable Conclusions

- ‘Big’ Data Example: Real-World Vehicle Usage
- ‘Merged’ Data Example: Urban Mobility



# Real World Vehicle Usage

For each vehicle:

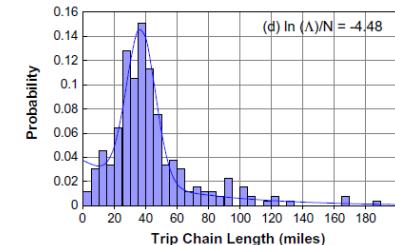
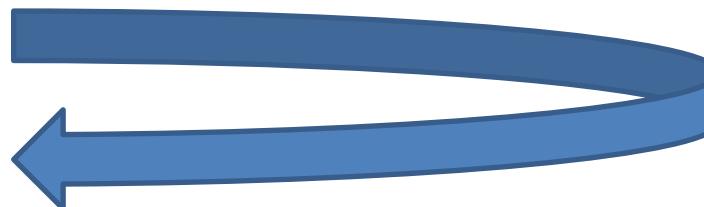
List of time-stamped GPS coordinates

List of trips (key-on-to-key-off)

List of trip chains (N hrs., 1-day)

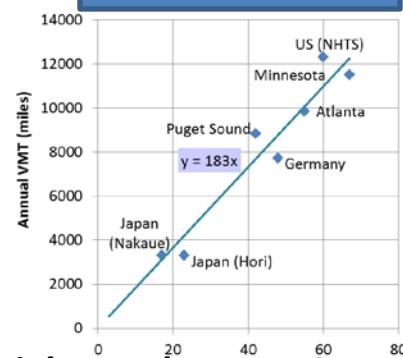
Individual Trip Chain Distance-Frequency Distribution

ITCD Parameters:  $\lambda, w, k, \mu, \sigma$

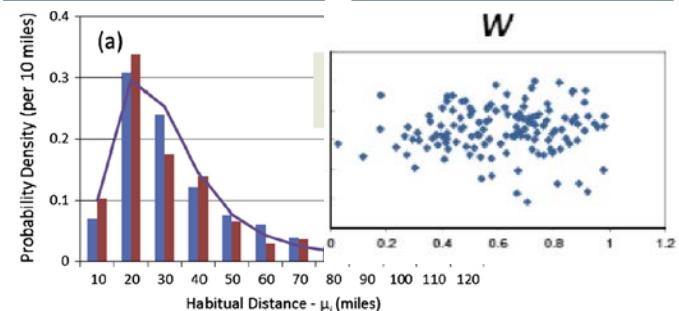


Rapid Computation of Decision Variables & Metrics

Scaling of Meta-Distributions



Distribution of ITDC Parameters

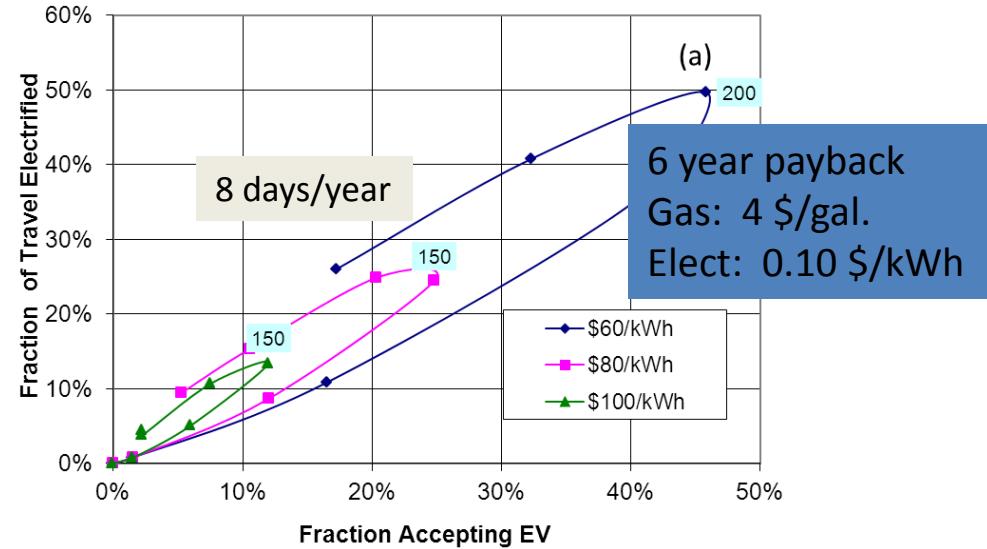
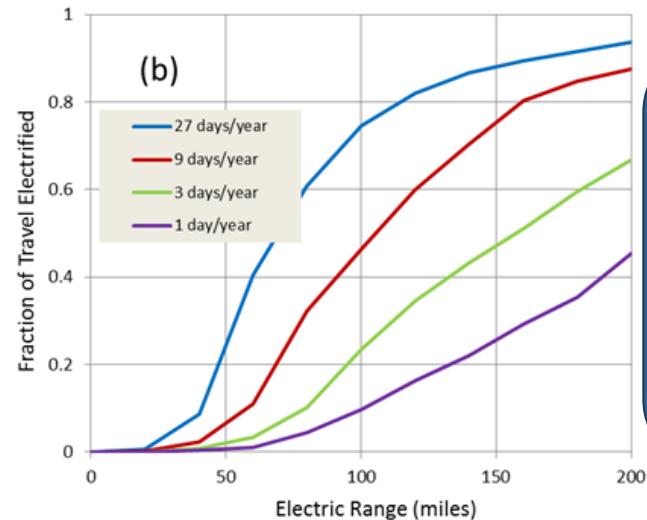
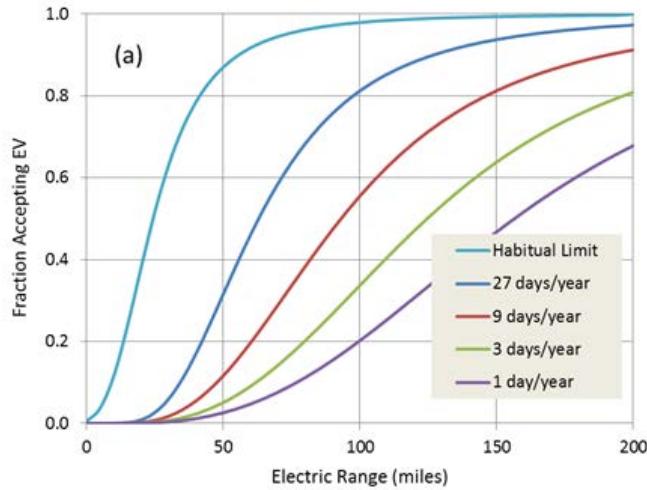


# Question #1: What is the ‘Optimal’ Range of a BEV or PHEV?

- Earliest work based on ensemble data (NHTS).
  - 80% of travel (90% of trips) electrified by BEV100
- Later work placed \$ cost on inconvenience.
  - Lost time to charging
  - Penalty + rental cost of alternative vehicle
- Recent work posits ‘threshold of inconvenience’ where BEV is rejected entirely.
  - Requires individual, longitudinal (‘big’) data
- Combine threshold method with total cost of ownership (TCO).



# BEV as 1-for-1 Replacements for ICEV

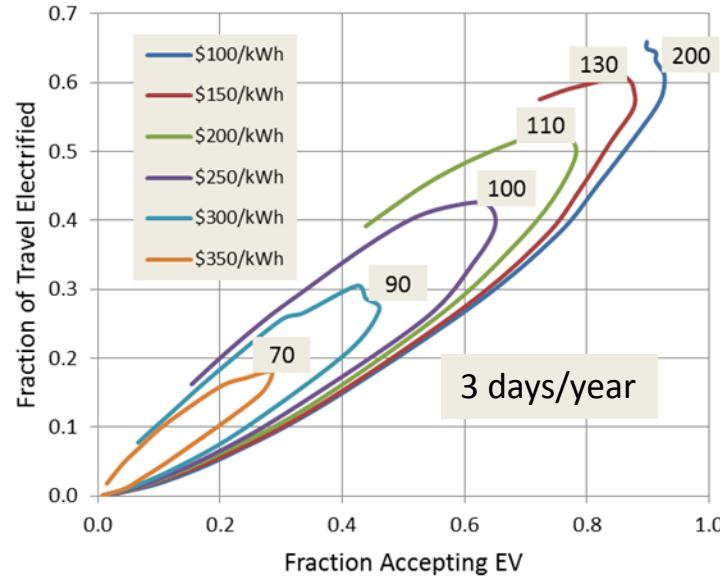
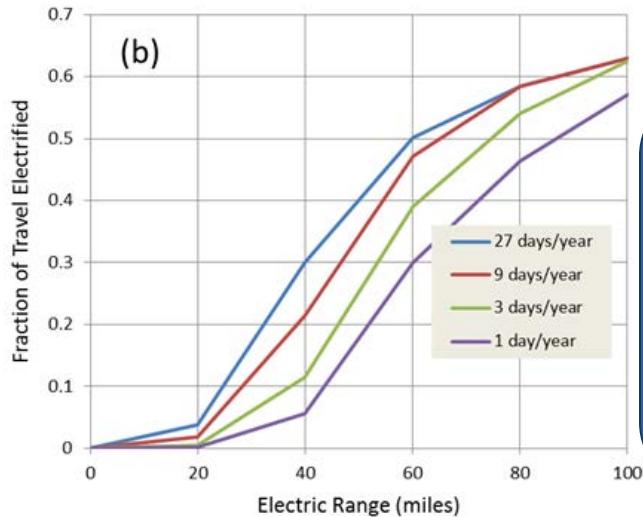
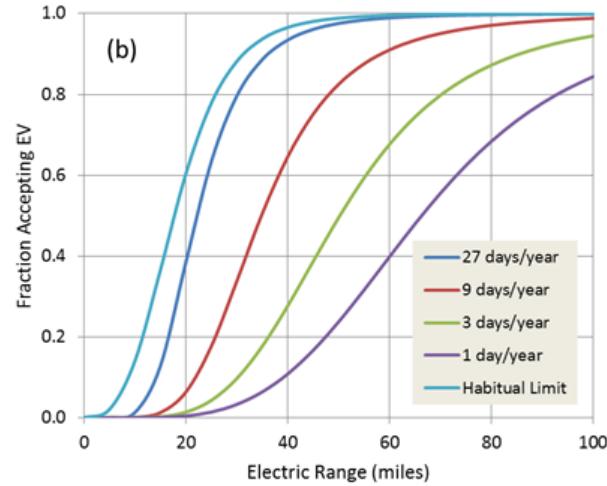


- Acceptance limited by infrequent, long trips.
- Below 300 miles range, acceptance is more sensitive to tolerance than to range itself!
- Optimal range is ~150 miles ...
- but is unaffordable at realistic battery cost!



# BEV in Two-Vehicle Households

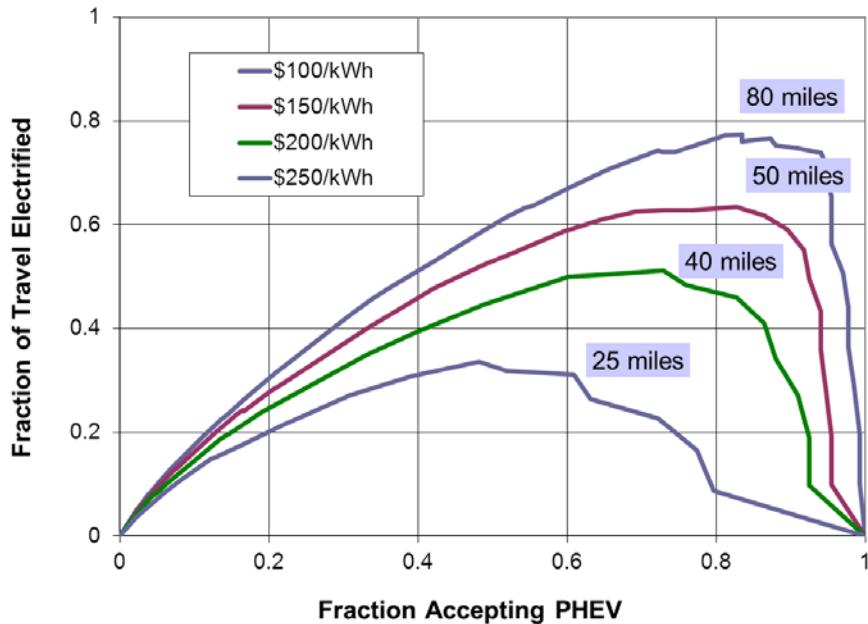
(82% of personal vehicles are in MVHH)



- Household usages are NOT correlated.
- Acceptance is high at only 80 miles range.
- One BEV in a 2VHH can electrify >50% of travel!
- Optimal range is 90-100 miles ... at today's cost!
- At-home charging only.
- Better value to due better use of battery capacity.



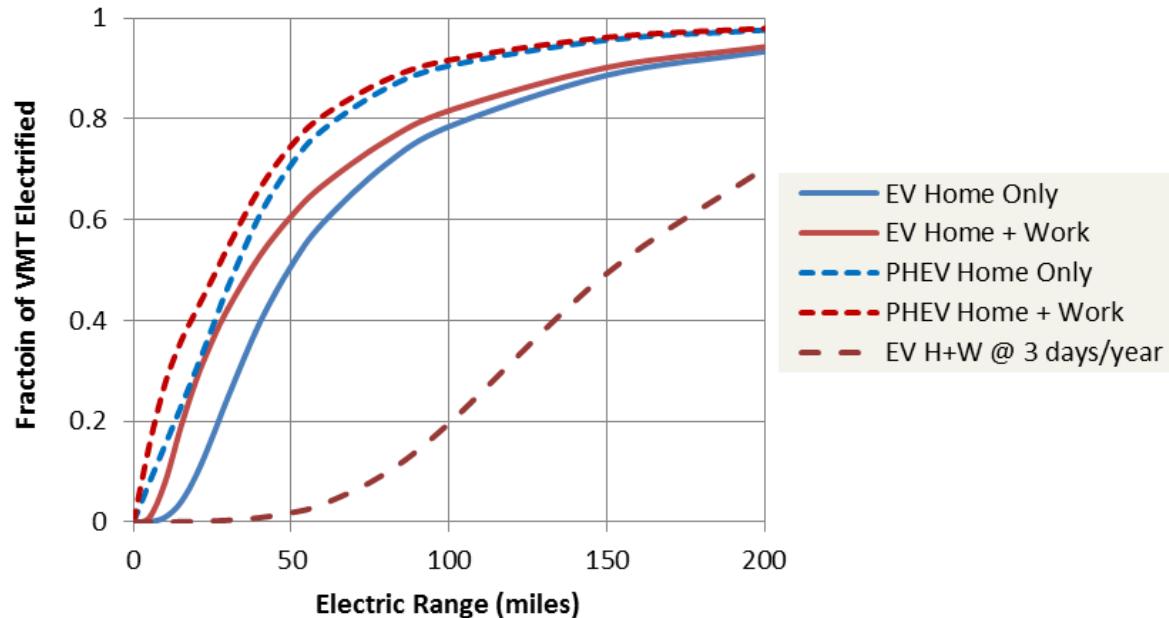
# Plug-In HEV



- Zero inconvenience
- Optimal range 40 miles at near-future cost
- 70% acceptance electrifies 50% of travel.
- Best value due to full use of battery capacity.



# Question #2: What are benefits of charging away from home?



- PHEV: maximum benefit for PHEV15, diminishes quickly with range.
- BEV: maximum benefit for BEV30, < 4% for BEV100.
- BEV with range large enough to achieve high acceptance does not need at-work/around-town charging. Neither do BEV in MVHH and PHEV!
- Long range BEV need inter-city, ultra-high rate charging only: the Tesla model!
- Is it time to rethink our public charging strategy?

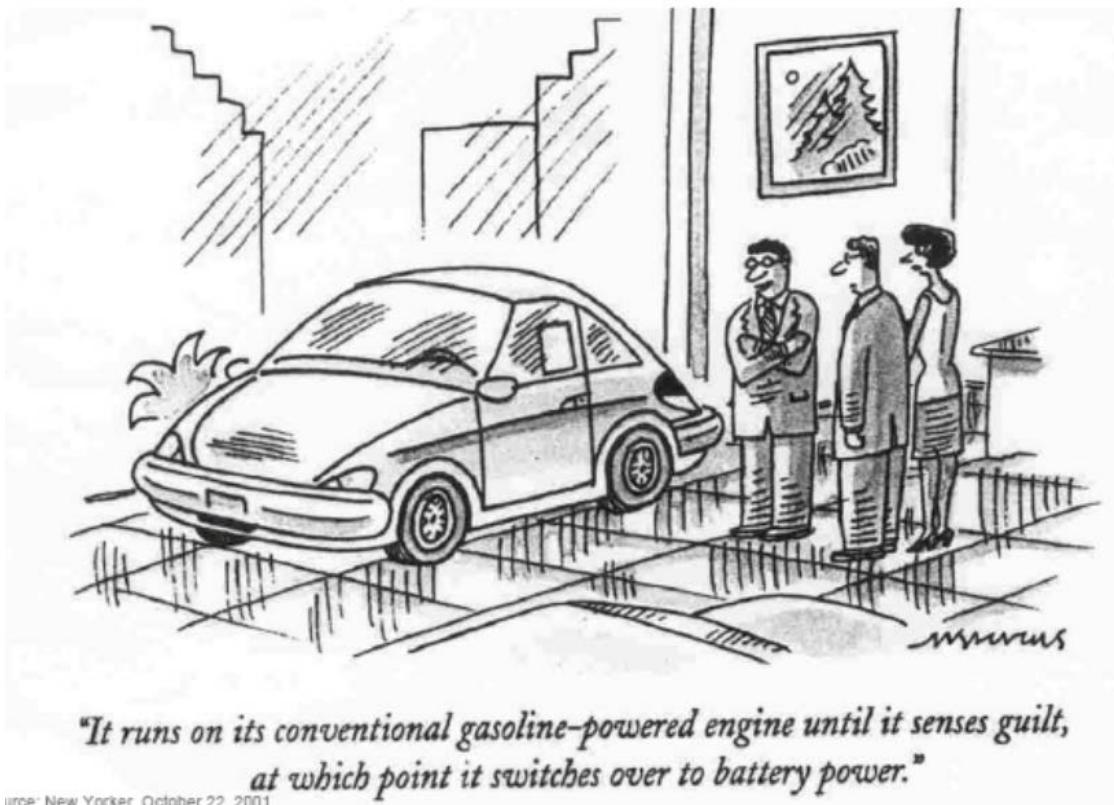


# Other Findings & Applications

- Vehicle usage pattern appears to be universal (4 studies so far with more in progress).
  - Single scale factor: labor market population density.
- On-road fuel economy (ORFE) & regional emissions.
  - Cold & hot starts.
  - Fraction of freeway vs. surface street driving (from GPS or inferred from speed trace).
  - Driving style.
  - Climate correction.
- Market segmentation (FE technology take rates).



# Thank You



*"It runs on its conventional gasoline-powered engine until it senses guilt,  
at which point it switches over to battery power."*

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## Questions?



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