The Complex Interactions between EVs and Travel Demand

Lisa Aultman-Hall, Professor

School of Engineering, University of Vermont

Acknowledgements

- My recent collaborators – Jon Dowds, Justine Sears, Paul Hines, Karen Glitman and Alex Hilshey

- Funding from the US DOT through the University Transportation Center (UTC) at the University of Vermont Transportation Research Center

Transportation Planning / Modeling Paradigm

Land Use
- Activities

Travel Demand
- Destinations
- Trips
- Modes

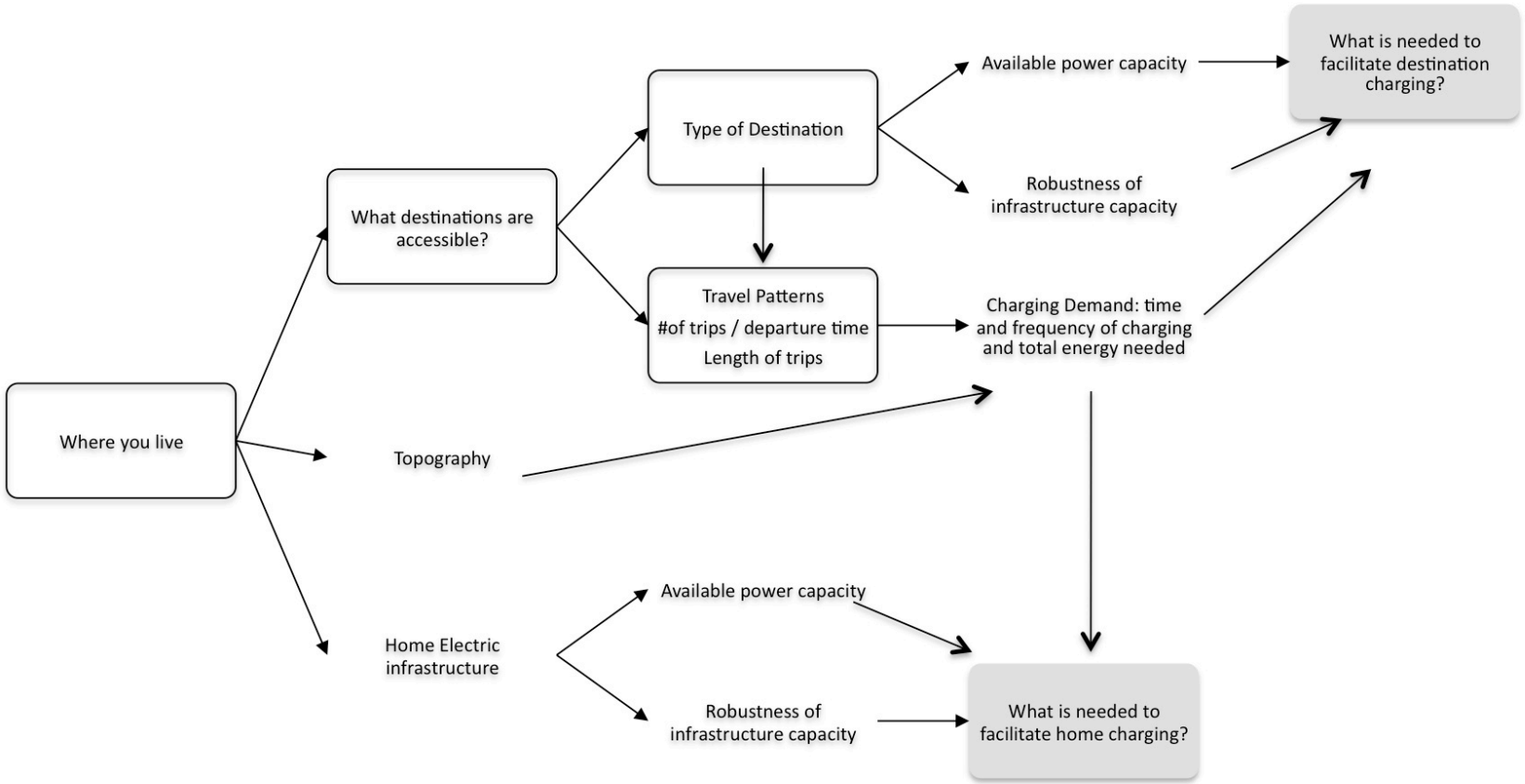
Infrastructure
- Services
- Operations

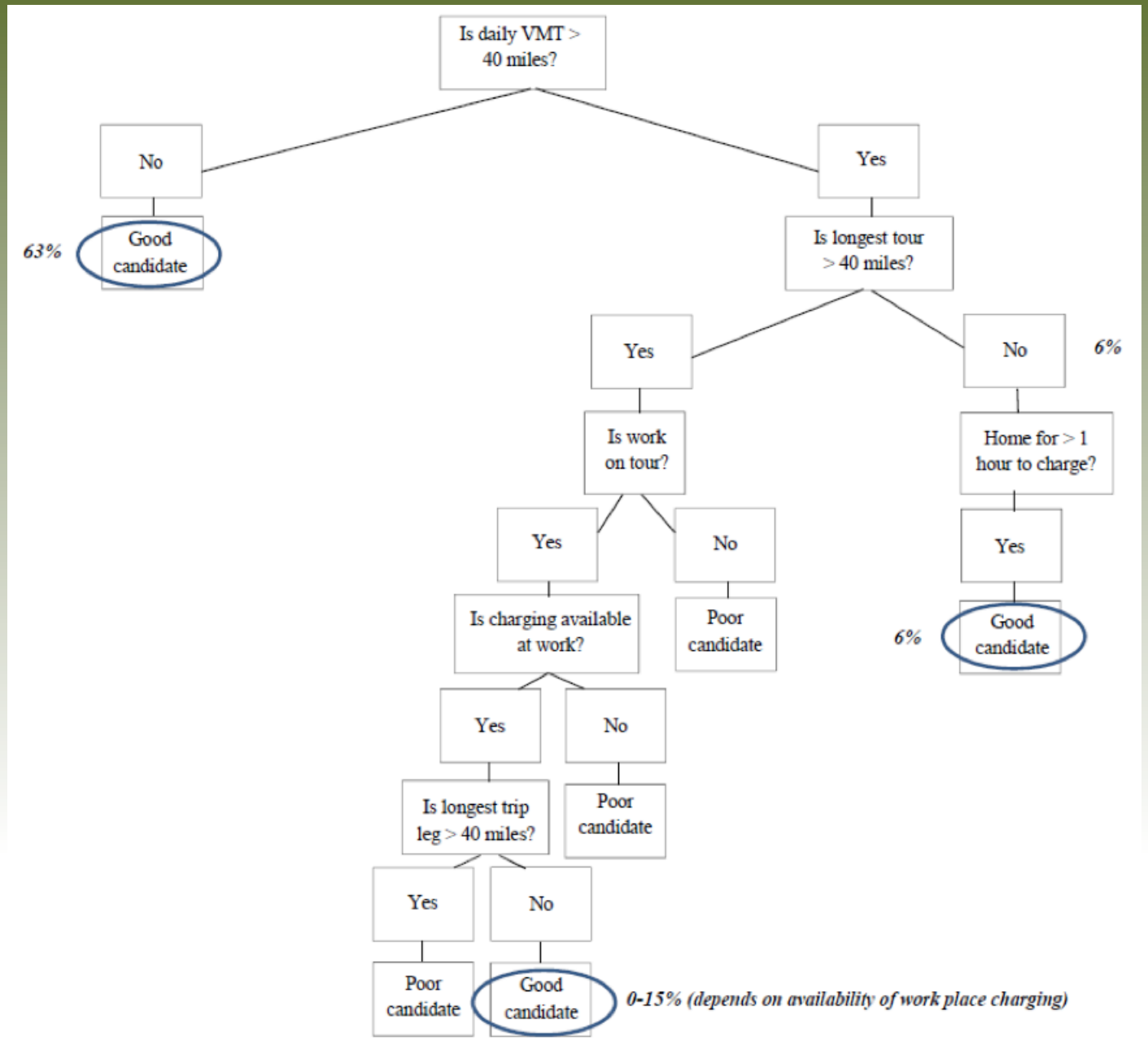
Research Questions

1. Can electric vehicles meet Vermonters' daily travel demand?
2. Are there rural areas or destinations where vehicles in need of away-from-home charging converge?
3. Are there spatial patterns in daily travel demand? Areas with clusters of high daily vehicle miles may require more power from the grid.

National Household Travel Survey

- NHTS has been conducted 1969, 1977, 1983, 1990, 1995 and 2009 by the Federal Highway Administration (FHWA)
- In 2009, daily travel data were collected for 150,000 households and 300,000 people nation-wide.
- Trip-related data includes mode, duration, distance, and purpose for one day
- Links to demographic, geographic, and economic data for analysis


Where you live
What destinations are accessible?
Type of Destination
Travel Patterns
#of trips / departure time
Length of trips
Available power capacity
Robustness of infrastructure capacity
Charging Demand: time and frequency of charging and total energy needed
What is needed to facilitate destination charging?
Topography
Home Electric infrastructure
Available power capacity
Robustness of infrastructure capacity
What is needed to facilitate home charging?

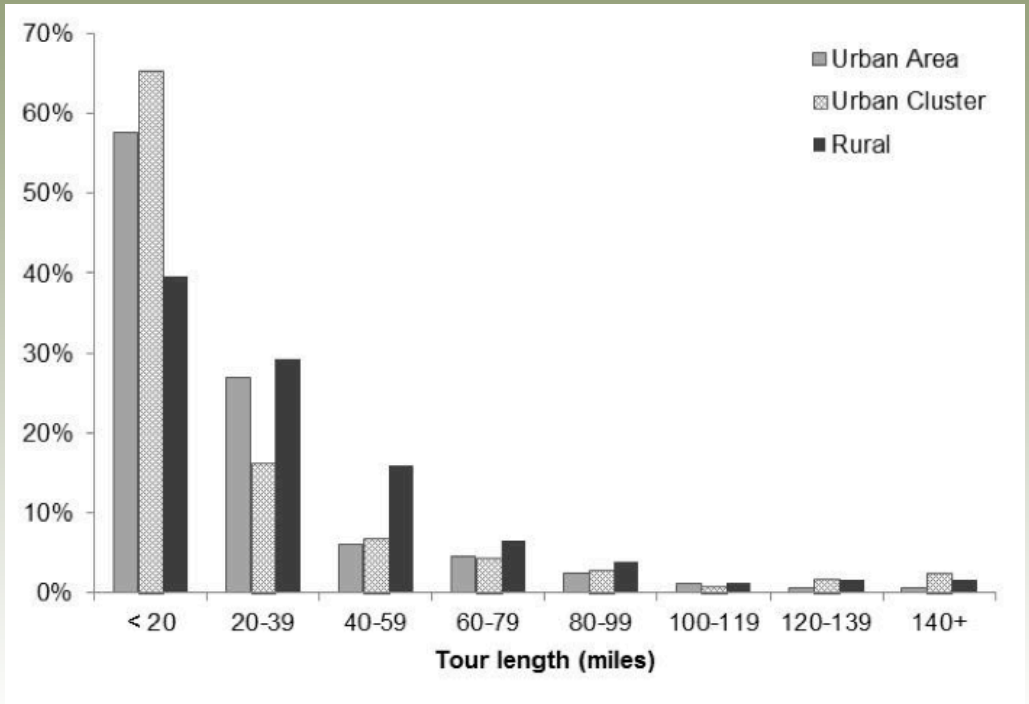

Is daily VMT > 40 miles?
No
Yes
63%
Good candidate
Is longest tour > 40 miles?
Yes
No
6%
Is work on tour?
Home for > 1 hour to charge?
Yes
No
Yes
Is charging available at work?
Poor candidate
6%
Good candidate
Yes
No
Is longest trip leg > 40 miles?
Poor candidate
Yes
No
Poor candidate
Good candidate
0-15% (depends on availability of work place charging)

Brief Results – Can EVs serve Vermont Travel Demand?

40 mile electric range		100 mile electric range	
% one-way trips < 40 miles	96%	% one-way trips < 100 miles	99%
% vehicles with daily travel < 40 miles	68%	% vehicles with daily travel < 100 miles	92%
% home tours < 40 miles	82%	% home tours < 100 miles	96%

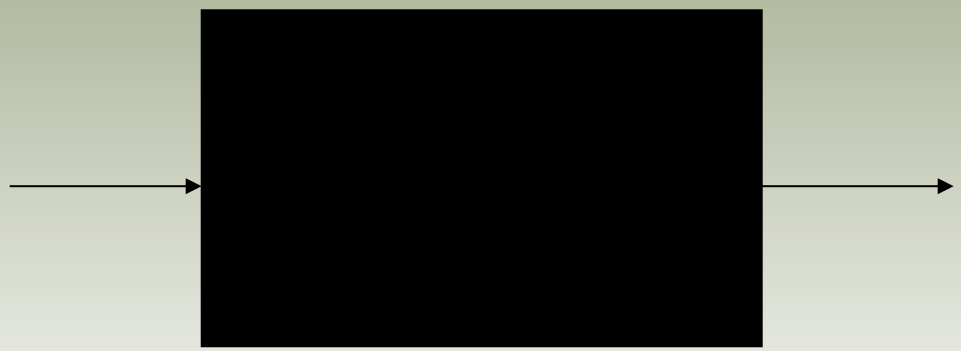
Brief Results – Charging and Clustering of Travel?

- Away from home charging demand will be dispersed
- Daily travel doesn't vary much by home location



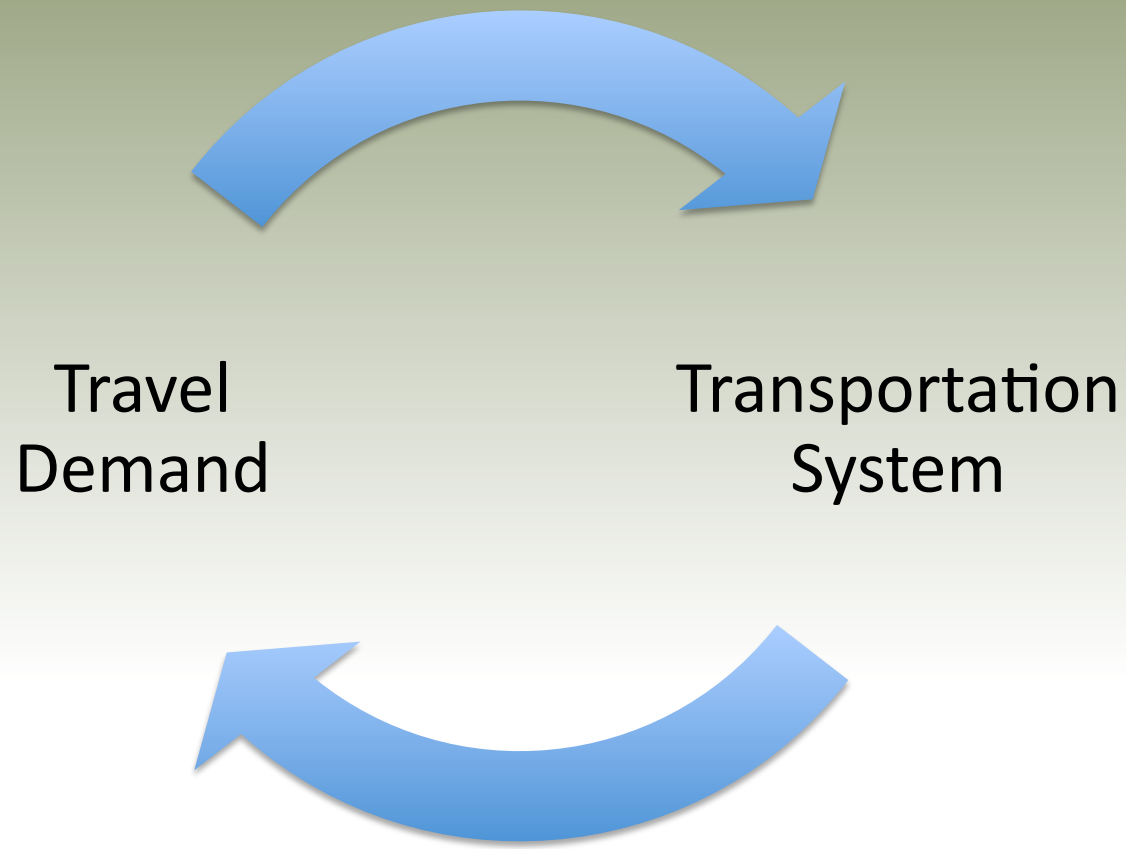
Traditional Framework

Land Use
- Zones
- Network
- Attributes



Transportation
- Volume
- Speed

Refocus



Complex Interaction of EVs and Travel Demand

- Range and Charging Stations
  - will affect activity and destination patterns
  - do we want EVs everywhere
  - can we coordinate this to advance mobility and sustainability goals

Complex Interaction of EVs and Travel Demand

- Rural Areas
  - lack of large concentrated destinations requires at-home charging
  - overlap of weakest links in the both power and transportation systems