Is “public” charging infrastructure important?

Range anxiety?

Where is the literature on this area of research?

90% plus of charging events will take place at home for most PEV drivers (evidence from many studies)

But workplace opportunities could shift that percentage

Basics

- Vehicle must have charger where parked at night
  - Nighttime electricity cheaper and more capacity (TOU pricing)
  - Car is not being used at night
  - Primary market will be households with multiple cars, place to park each night, easy electrical access
  - Secondary markets will be homes and workplaces in which parking is reserved, but may require some investments for charging
  - Tertiary markets will be drivers who will rely on public charging

Charge network has complex inputs for design

- Diverse users: PHEV 10s, 40s, BEVs
  - And sizes, low speed micros to midsized vehicles
- Diverse equipment: Level 1, 2, DC fast
- Diverse locations: home, work, public (lots of options here)
- Diverse driver lifestyles, households that drive 1-100 miles a day.., or different distances every day…
- And additional demands from grid, around time of use, demand response, etc…

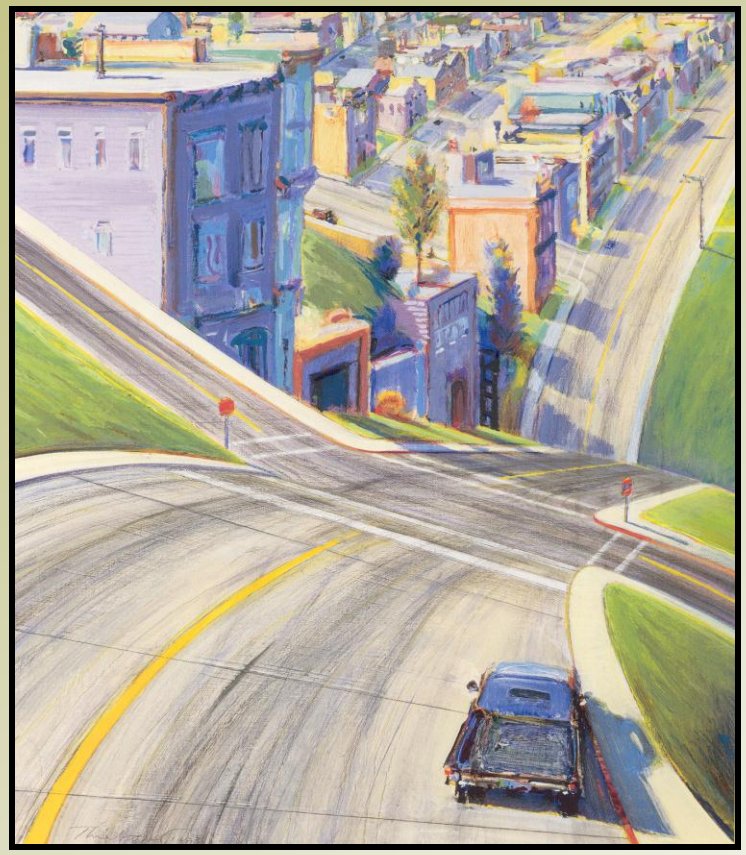
IEA "Lessons Learned" from 1990s deployment workshops Oct 2007-June 2010: 2 in California, 1 US East Coast, 2 in Japan, 1 in Switzerland, 2 in Sweden, 1 in the U.K., 1 in France, 1 in Germany

- **OEMS**: PSA, Renault, GM (retired), Toyota, Honda US, Nissan, BMW, Smart, Volvo, Solectria, Esoro, Protoscar, TH!NK, ABB, IBM, DBT (Douaisienne de Basse Tension=infrastructure)
- **Utilities**: SCE, EDF, TEPCO, Vattenfall, Fortis, e-on, Vätgas Sverige, NY Power Authority, SDGE, RWE, Boston Edison
- **Governments/agencies**: CARB, DOE, Vinnova, STEM, NESCAUM, NAVC NE Advanced Vehicle Consortium, EVermont, UK Dep. Transport, OLEV, Cenex, ADEME, NOW Nationale Organisation Wasserstoff und Brennstoffzellen-Technologie
- **Universities/research**: Tokyo, UCD, TU Chemnitz, INRIA, CRIEPI
- **Project veterans**: Göteborg, Mendrisio, La Rochelle, PrEView,
- **IEA representatives**

Lessons Learned

- **How much "public infrastructure needed"?**
  - **Public "fast" charging (Level 2)** infrastructure was expensive & over subsidized
  - In all deployments, **public infrastructure was not well used (**Stockholm, Gotenburg, Berlin, California, La Rochelle, Mendrisio)
  - "Network is not a business" (Vattenfall, Berlin)
  - Often, main reasons for use of chargers was as reserved parking & free electricity
  - TEPCO "fast charge" study leading fast charge development in Japan, but is a single study of a narrow user group.

UC Davis Research

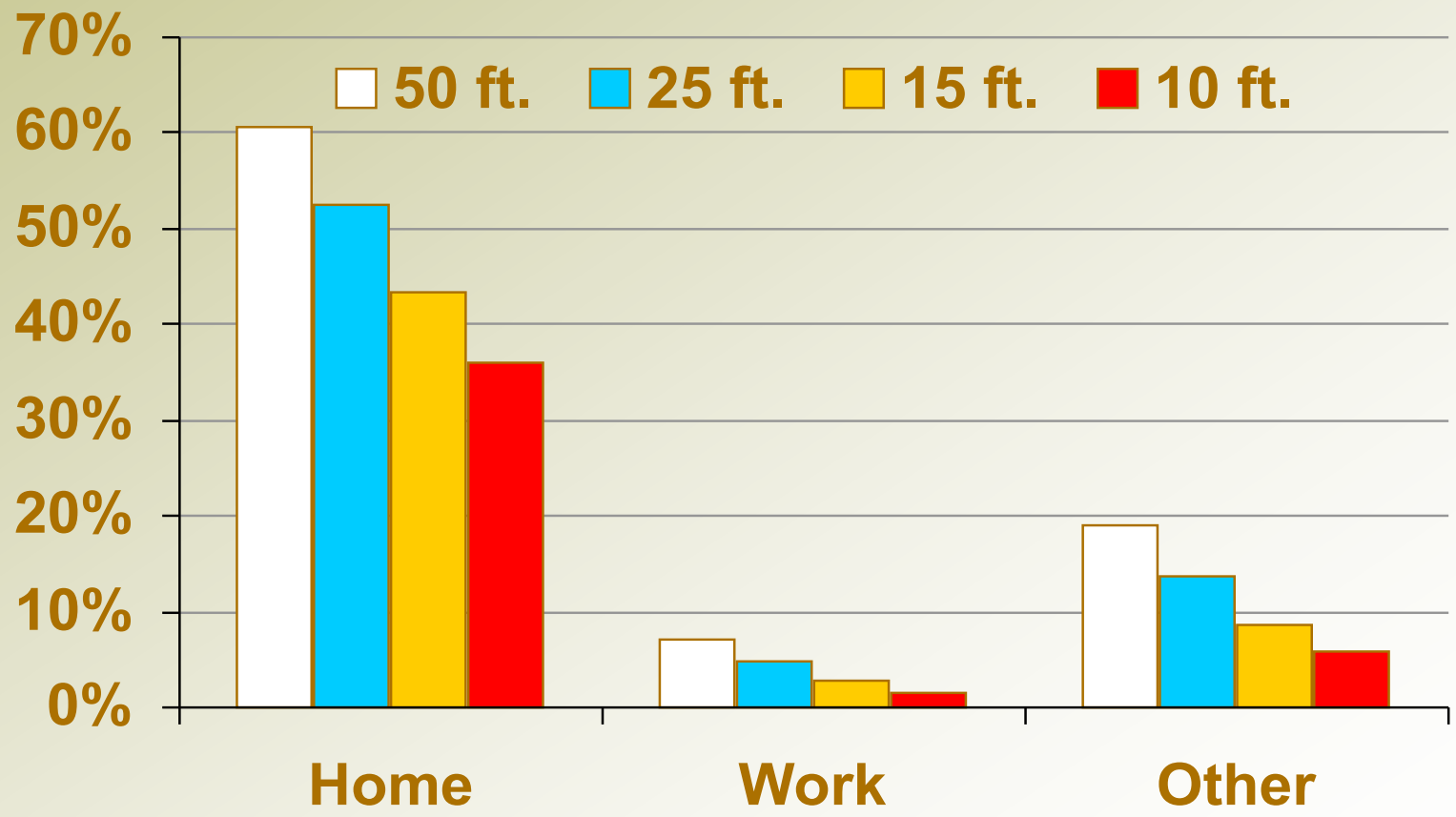


PH&EV center demos & surveys with infrastructure research.

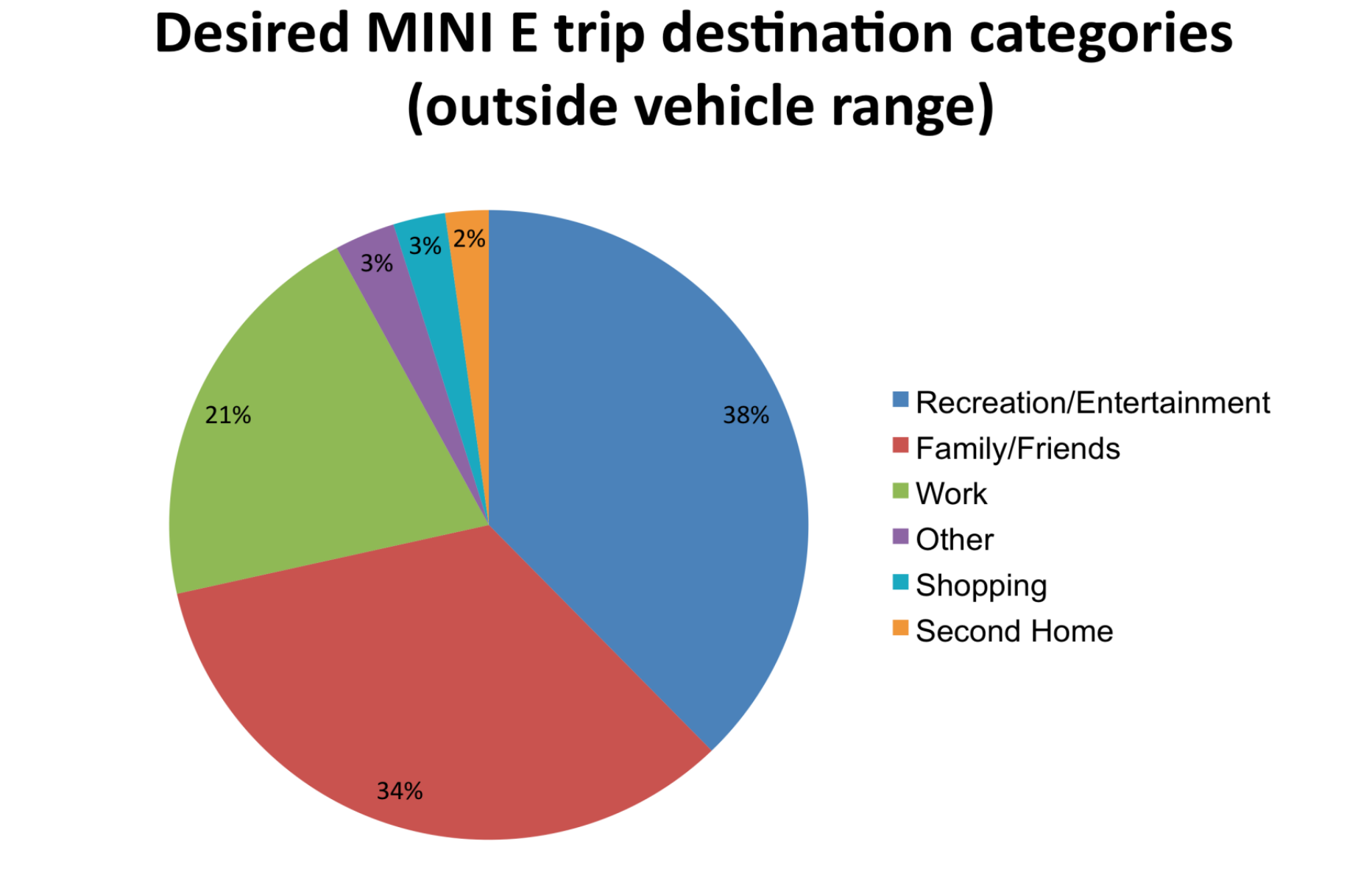
- California ZEV Mandate Consumer Studies (1990-1998):
- Nissan Hypermini (2000-2001)
- **PHEV conversions in 80 California households (2007-2010)**
- **BMW MINI E (2009-2011) 50 in detail, 150 plus online surveys**
- Nissan Leaf / Charge network usage San Diego (2010-2012)

How much does a good place to park shape market?

- Berlin 7%, San Francisco 20% have a garage
- Most of USA, California (about 50% of new car buyers) a place to park 25 feet from electricity each night



MINI E drivers like their car, so they want chargers to visit their favorite beach or uncle Phil's house



San Diego PEV Market and Infrastructure Usage Project (2010-2013) P.I. T. Turrentine, Lead: Jonn Axsen

Funding: U.S. DOE, California Energy Commission

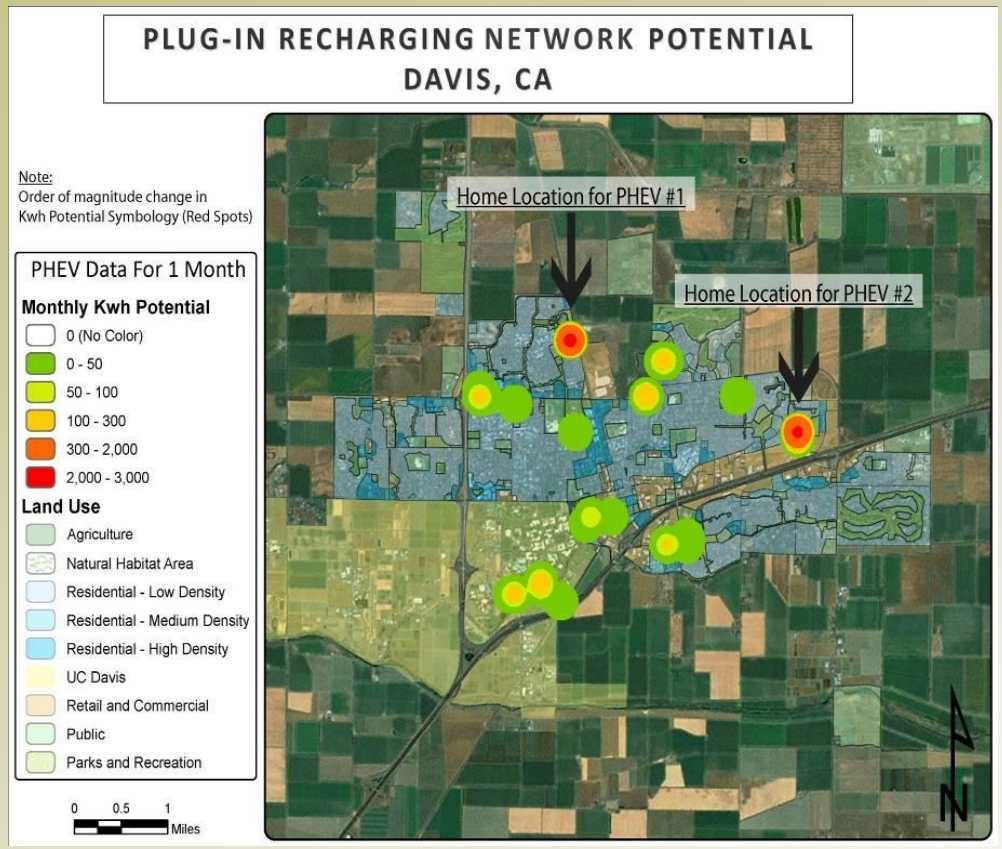
Team: ECOtality, Idaho National Lab, Nissan, SDG&E, PH&EV Center

1,000 Nissan Leafs, 75 GM Volts
1000 Level 2 home chargers
1200 Level 2 public chargers
60 public DC fast Chargers

- PH&EV Center Study Tasks
- PEV use & recharge patterns
- Use of experimental EV Time of Use rates,
- Optimal placing of public charging infrastructure.
- Data for GIS planning toolbox for PEV infrastructure
- Piggyback study of PEV market potential in San Diego

Geographical Information Systems "Toolbox" for Design, Rollout and Optimization of PEV Charge Networks (2010-2013)

Funding: CEC PIER PH&EV Center
Team: PH&EV Center GIS Team; Mike Nicholas: Team Leader



Analytic Topics:

- Optimal design of network for PEV users
- Avoid stranded assets
- Favor night-time charging
- "Fast" vs. Level 2 usage patterns
- "Energy" map of PEVs for demand response
- Identify high demand locations to protect grid
- Integrate with regional planning goals