



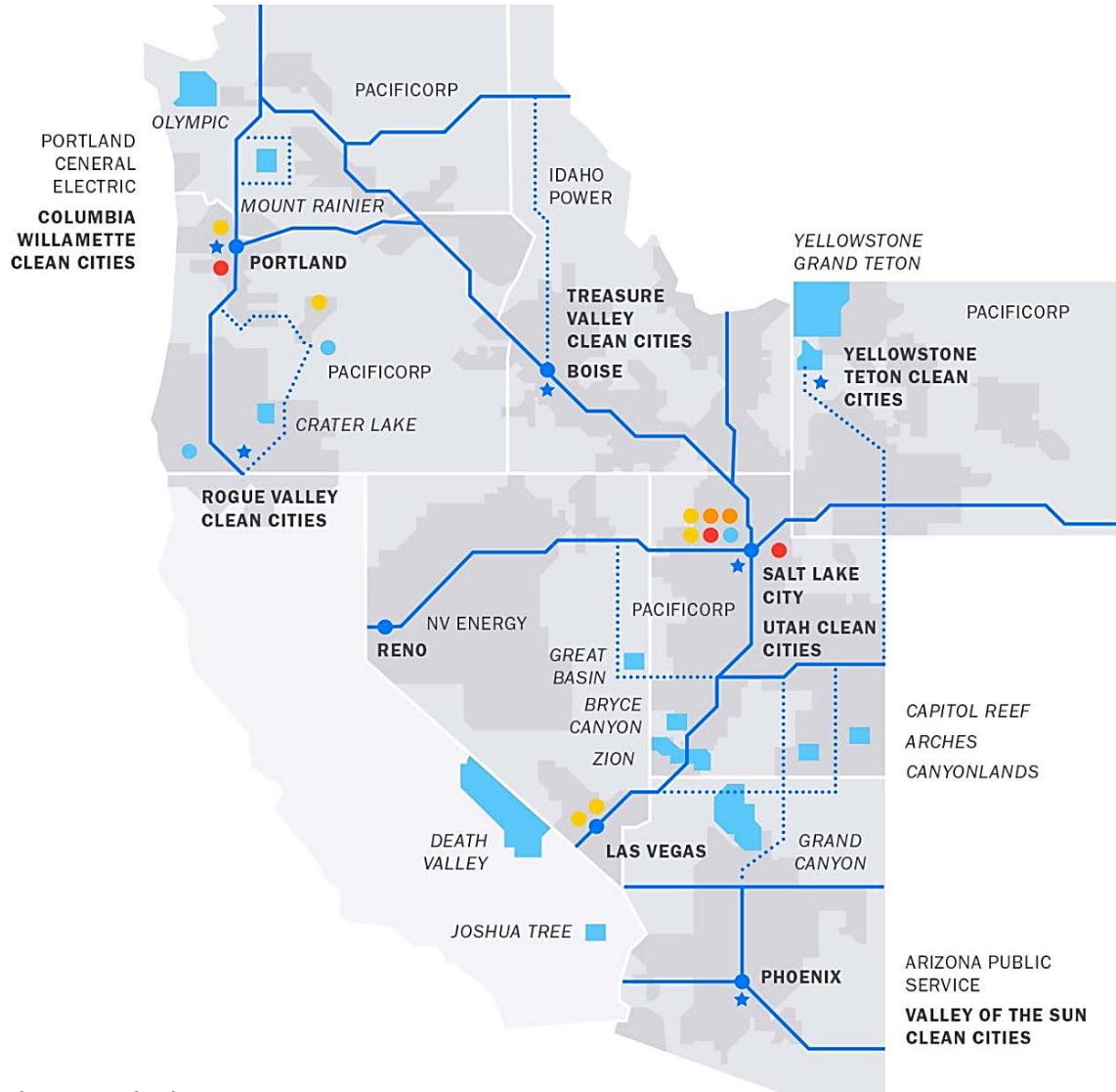
Electrifying Road Trips to and from National Parks in the Western United States

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Research Questions

WSEV@Scale – DOE-FOA Project (PI: PacifiCorp)
Western Smart Regional EV Adoption and Infrastructure at Scale

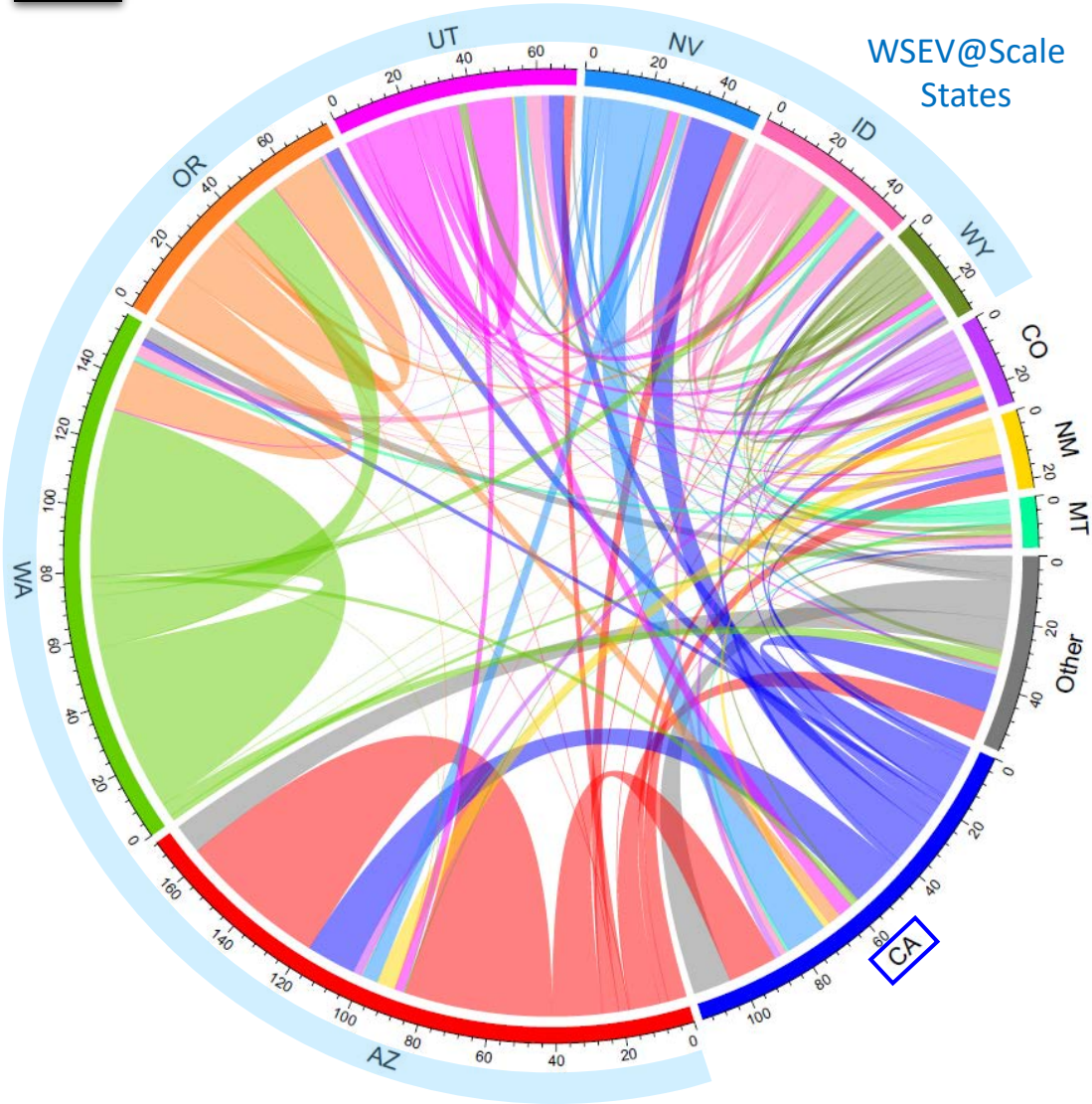


To support electrified road trips to, from, and through the national parks (or National Park System [NPS] units)

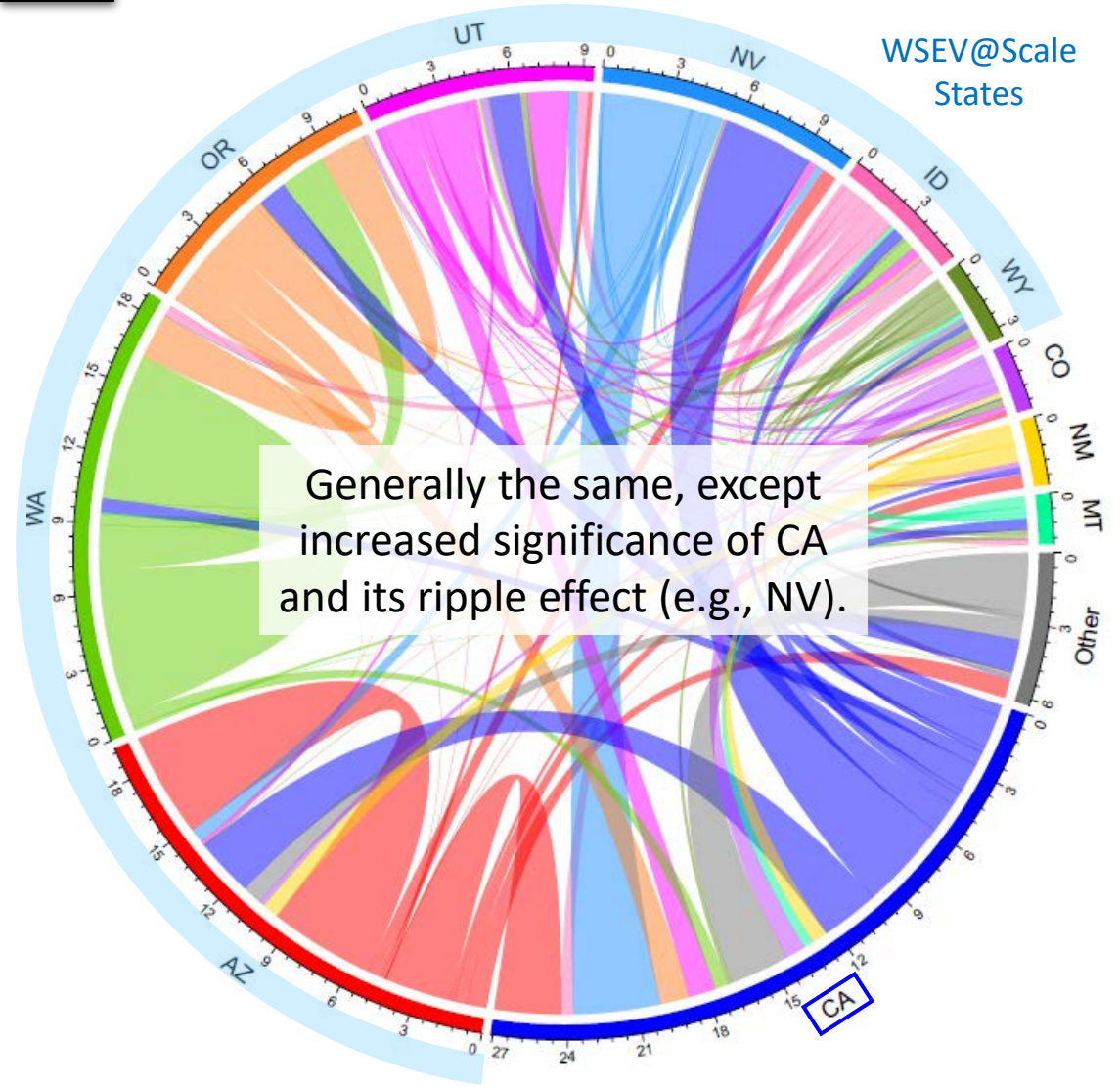
- Where do we need on-route (or waypoint) and destination chargers, and how many?
- What is the impact of seasonal variations in both general road trips (e.g., Thanksgiving) and those related to NPS units?
- Do we have appropriate electric grid ready along the routes and/or in the NPS units?
- What equity implications would be worth considering?

Road Trips to, From, and Through WSEV@Scale Region

ALL 0.5 million/day

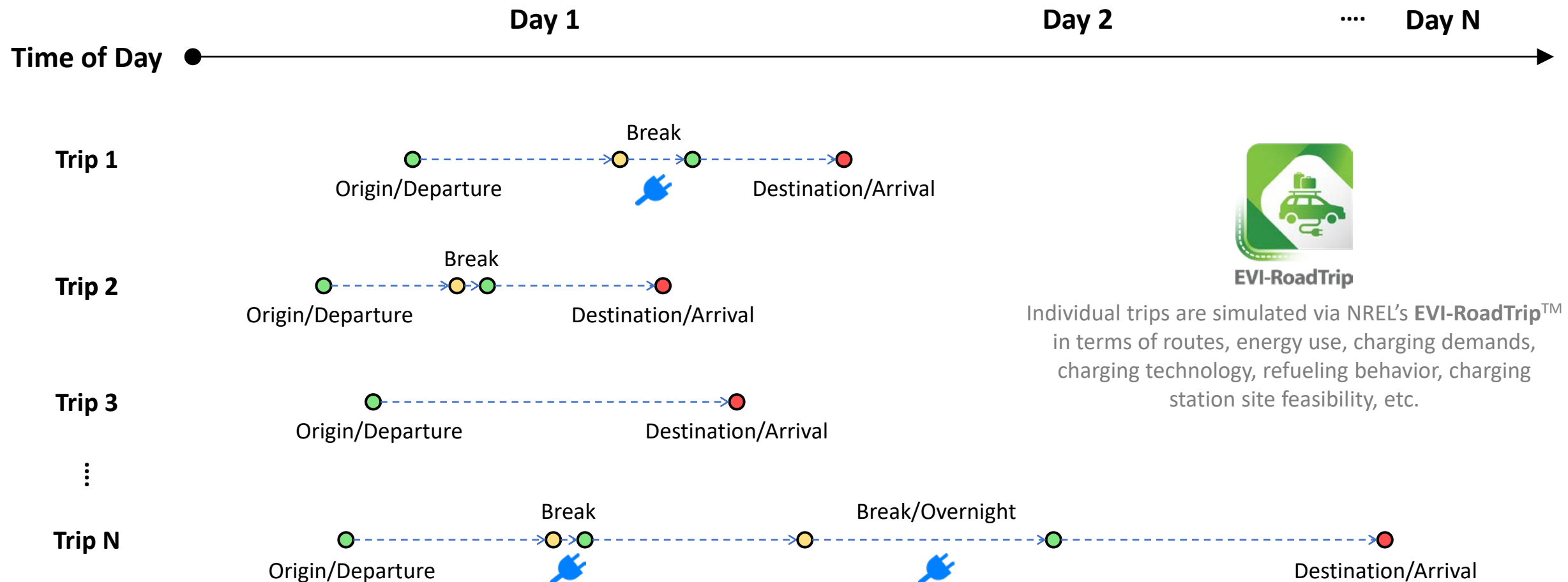


BEV 0.06 million/day



EV Trip and Charging Simulation (1)

- Not all road trips are created equal.
- Different people do road trips differently and have different needs/goals.
- We strive to incorporate the heterogeneity and realism, although data for long-distance travel are scant.

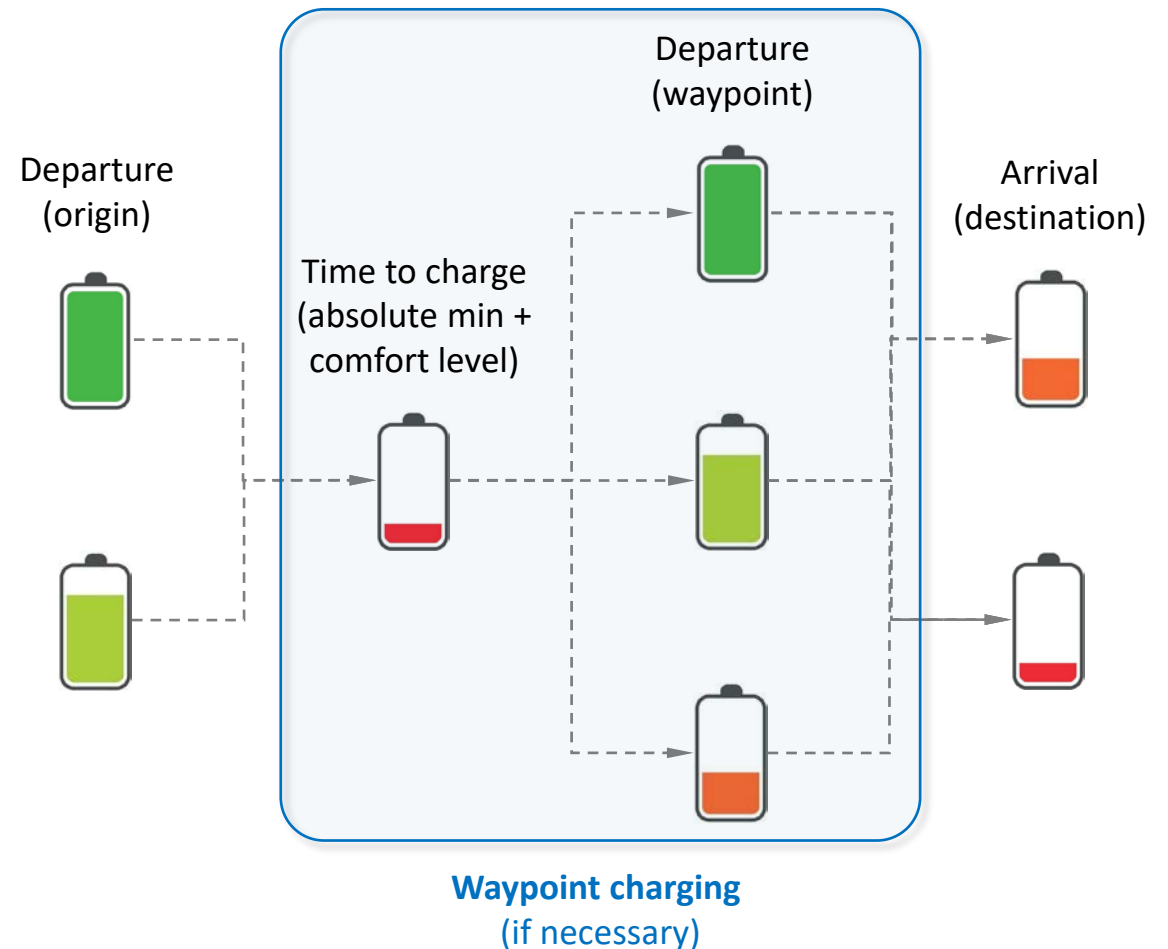
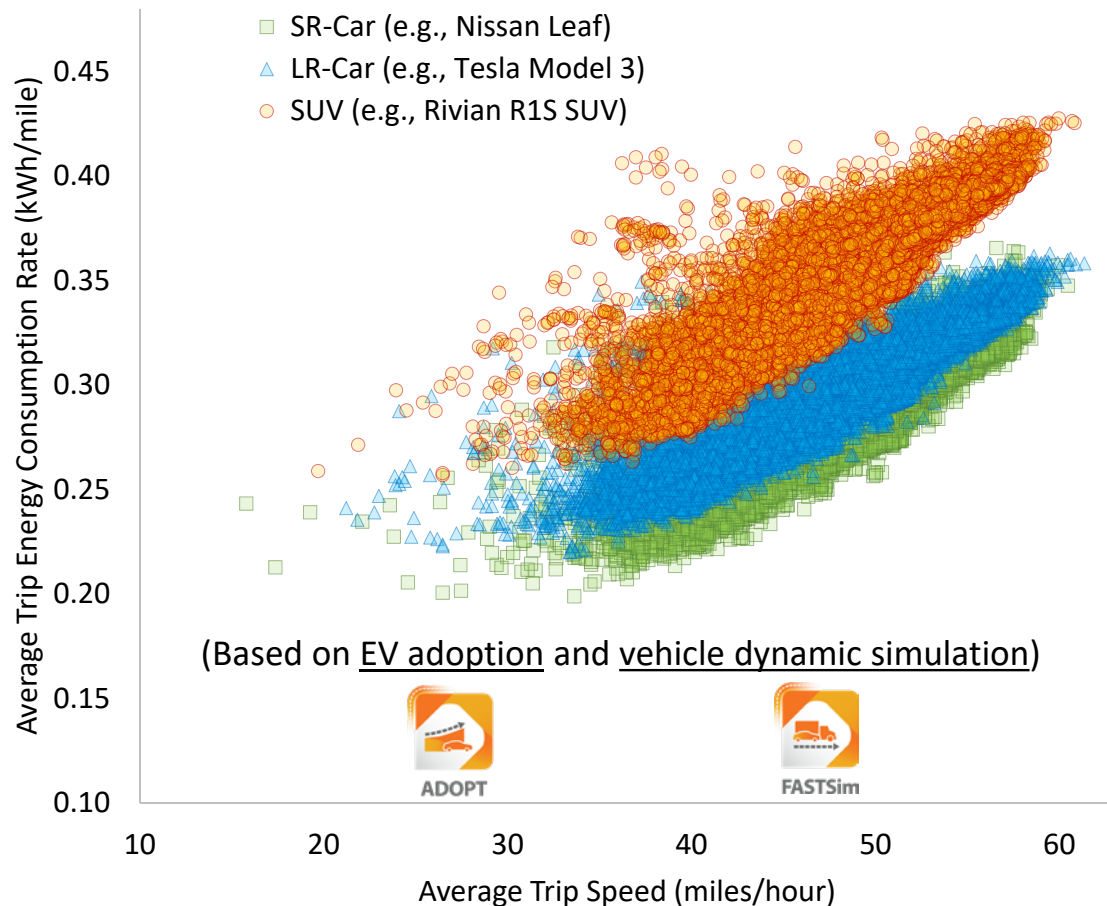


EV Trip and Charging Simulation (2)

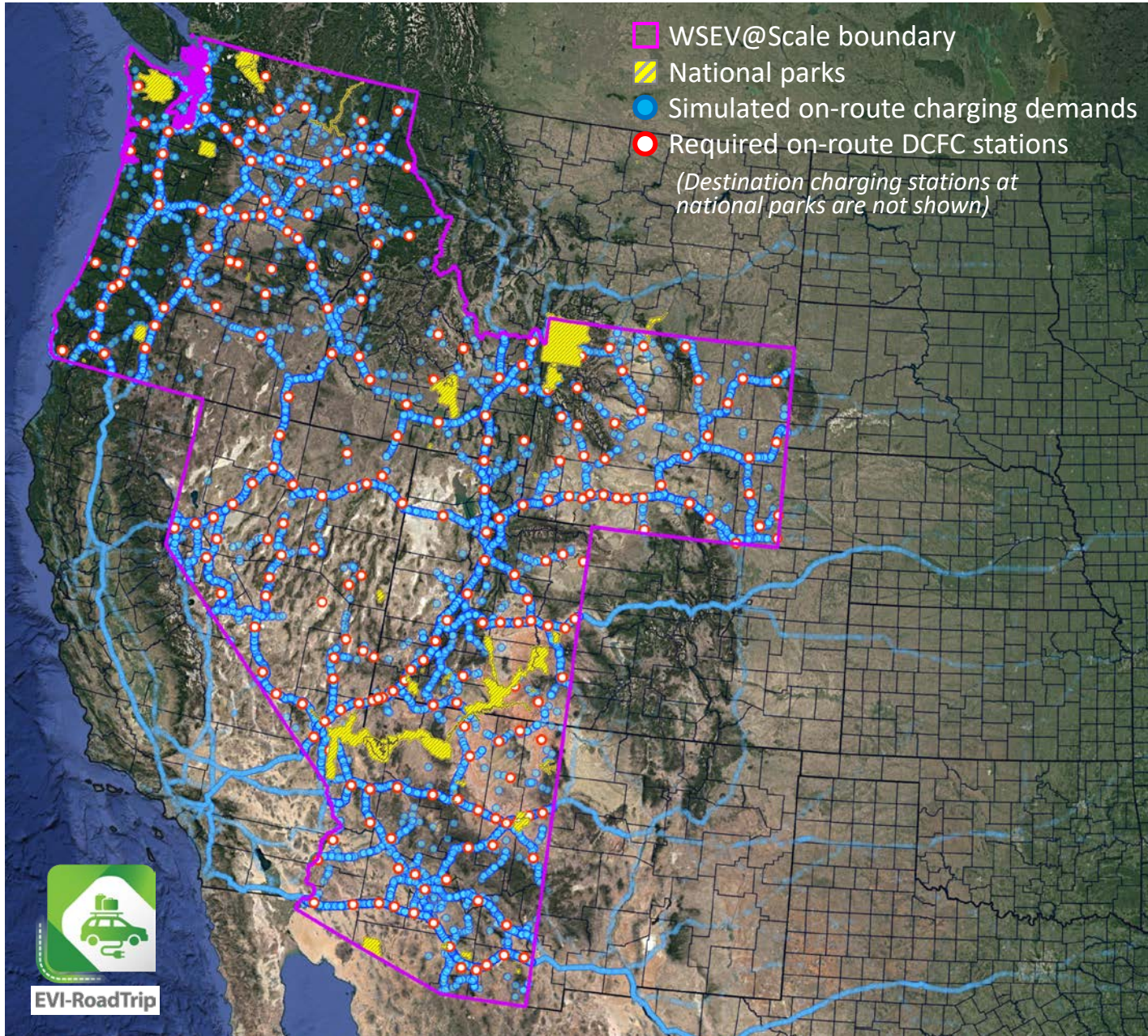
Energy consumption is estimated for each trip, based on vehicle type and driving conditions (speed, cargo, climate, etc.).

- Initial (at origin) and arrival state of charge (SOC)?
- When, where, and whether people charge?
- When is charging, and how much?

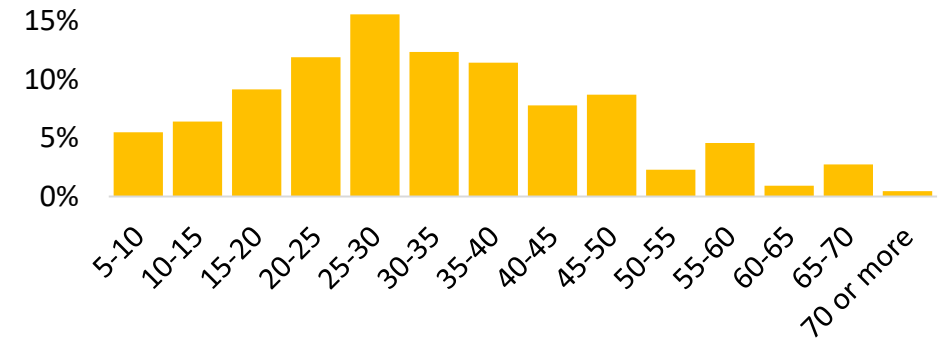
Energy Consumption Rate for Individual Trips



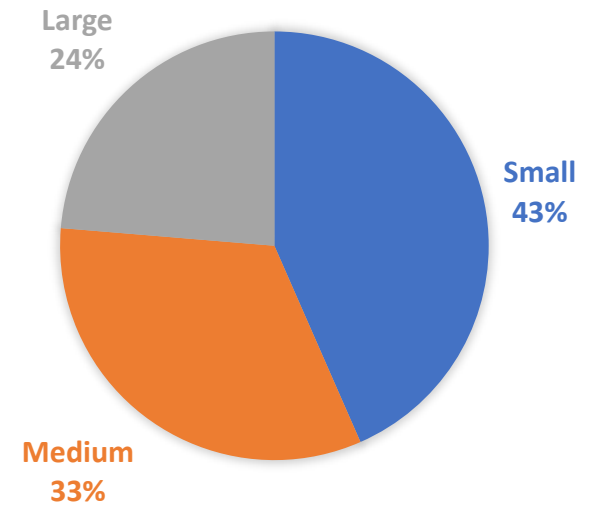
Simulated DC Fast Charging Station Network



Gap (miles) Between Simulated DCFC Stations



**Size of Simulated DCFC Stations (about 250)
(vs. around 10,000 gas stations)**



Estimated DCFC ports required: 2,000

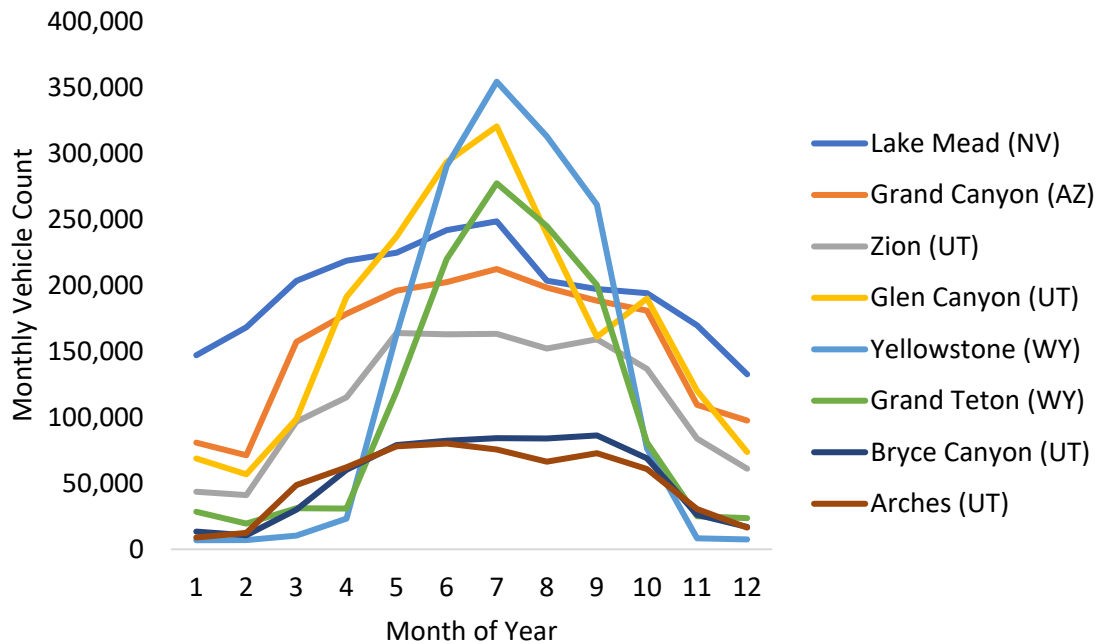
Seasonal Variation of Road Trips

The significance of NPS-related travel: This is a rather unique characteristic in the WSEV@Scale region.

NPS-Bound (40%)

General Road Trips (60%)

Vehicle Count by Month
(Adapted from www.nps.gov)



Largest seasonal variation in general road trips (Federal Highway Administration study):

Thanksgiving (Tuesday/Wednesday): +15%

Thanksgiving (Thursday): -30%

Christmas (12/25): -40%

No notably significant variation during summer.

Summer: General (almost no change) vs. NPS (+50%)
Winter: General (up to -40%) vs. NPS (lower than average).

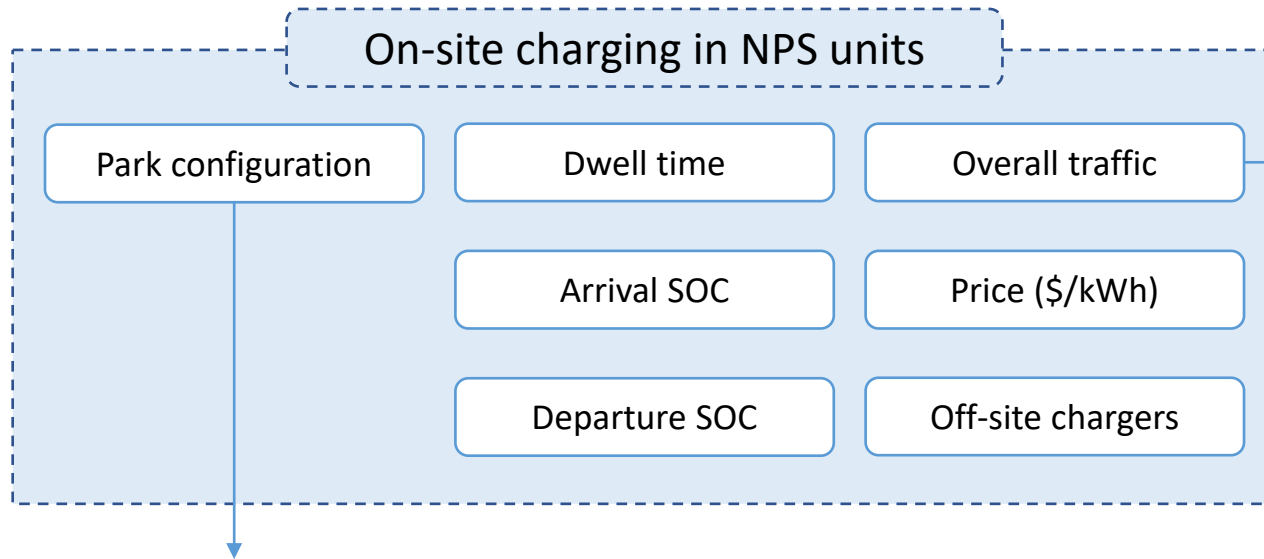
Charging station network sizing based on summer or winter?
Summer-based: Low utilization rate (and revenue) in winter.
Winter-based: Cannot absorb/support peak demands in summer.

- NPS units and recreation: +50% (summer) and -50% (winter) from annual average.
- Summer: 60/40 share between NPS/recreation vs. general.
- Winter: NPS may not be popular destinations, but ski resorts are, and cold climate can increase charging demands.

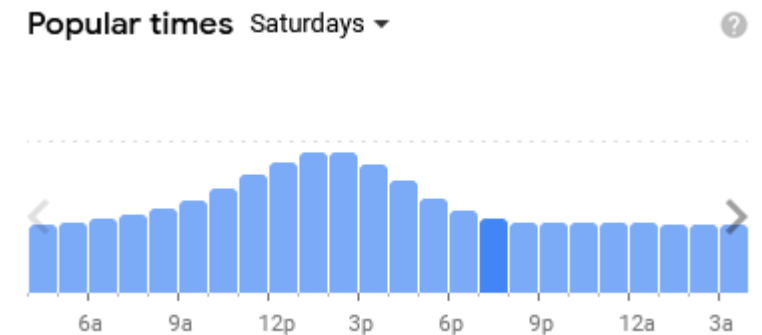
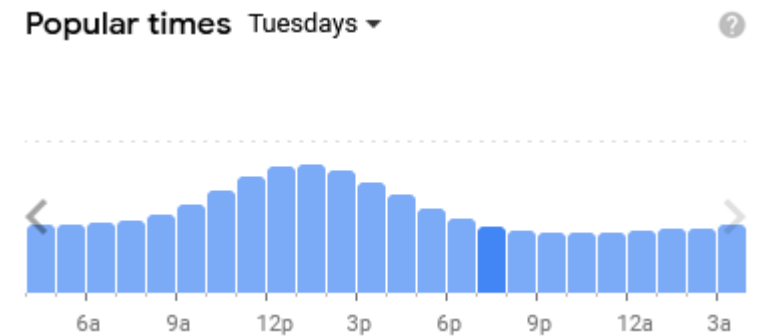
On-Route Overnight Charging and On-Site Charging in NPS Units

Opportunity (not on-the-go) charging infrastructure:

- 1,000–2,000 Level 2 (L2) ports for on-route overnight charging (at hotels, rental properties, etc.).
- 50–100 L2/DCFC ports for on-site charging per NPS unit (on average).
- NPS units are vast; people tend to keep moving/driving unless hiking or similar activity.



Typically peaking around early afternoon, and people stay a few hours on the property.

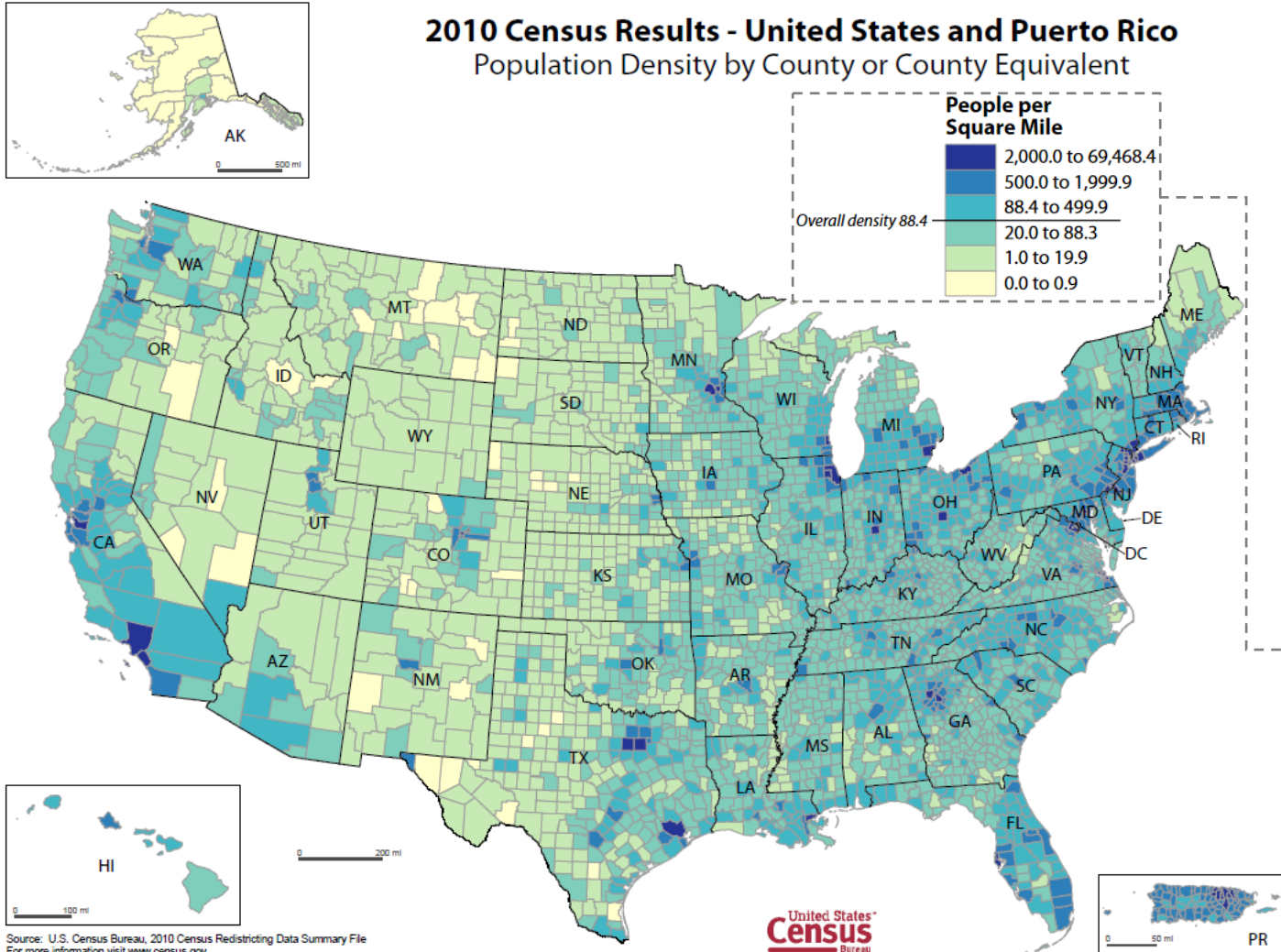


Grand Canyon, AZ: Hub-and-spoke (personal cars are not allowed inside the park; favorable condition for on-site charging).

Arches, UT: Controlled traffic (no “large” parking lots; not much opportunity for charging).

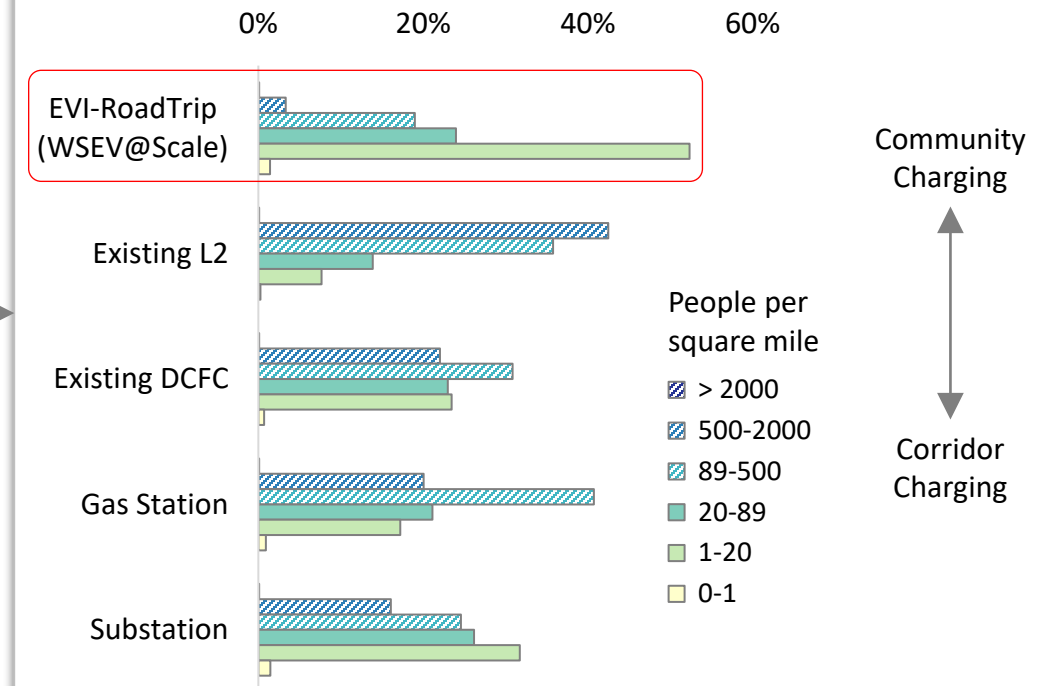
Equity Implications: Rural vs. Urban

2010 Census Results - United States and Puerto Rico
Population Density by County or County Equivalent



- WSEV@Scale region is predominantly rural.
- Paradigm of charging infrastructure for road trips: corridor charging (in rural areas).
- Existing charging infrastructure: biased toward community charging (even more so for L2).
- Similarity between existing DCFC and gas stations.

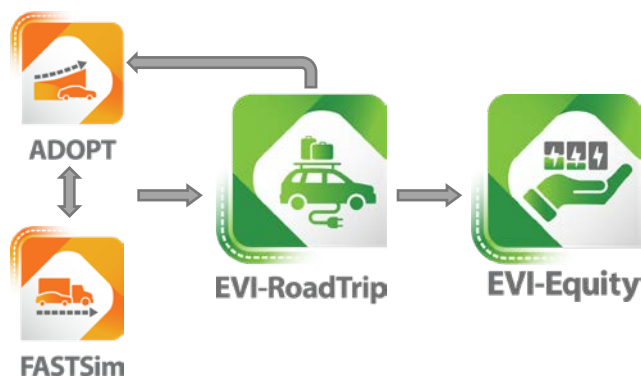
Refueling Infrastructure by Population Density



Source: U.S. Census Bureau. 2010. "Population Density by County or County Equivalent: 2010." https://www2.census.gov/geo/pdfs/maps-data/maps/thematic/us_popdensity_2010map.pdf.

Summary

- Uniqueness of road trips:
 - Home charging (the dominant form of EV charging) becomes almost irrelevant.
 - Potentially small cohort of vehicle types may be used for road trips (especially for NPS units).
 - Impact of cargo (e.g., roof storage, trailer).
- Estimated required number of charging ports to support electrified road trips in the WSEV@Scale region:
 - On-route DCFC: about 2,000 (not very sensitive to seasonal variations).
 - On-route overnight charging L2 (hotels, etc.): 1,000–2,000.
 - On-site opportunity charging L2: 50–100 (per NPS unit, on average).
- Infrastructure planning:
 - Must be based on summer, winter, or annual average demands?
 - Equity implications—rural vs. urban; mostly benefiting high-income and city residents; gas station business model.
 - Can we develop a “prioritized” strategy as we build out the network over time?
 - Any feedback loop between charging infrastructure (for road trips) and EV adoption?



ADOPT
FASTSim
EVI-RoadTrip
EVI-Equity

<https://www.nrel.gov/transportation/adopt.html>
<https://www.nrel.gov/transportation/fastsim.html>
<https://www.nrel.gov/transportation/evi-roadtrip.html>
<https://www.nrel.gov/transportation/evi-equity.html>

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