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?

EV: electric vehicle
Road Trips to, From, and Through WSEV@Scale Region

ALL 0.5 million/day

BEV 0.06 million/day

Generally the same, except increased significance of CA and its ripple effect (e.g., NV).

BEV: battery-electric vehicle

(1,000 trips/day)
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.

Individual trips are simulated via NREL's EVI-RoadTrip™ in terms of routes, energy use, charging demands, charging technology, refueling behavior, charging station site feasibility, etc.
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**

- SR-Car (e.g., Nissan Leaf)
- LR-Car (e.g., Tesla Model 3)
- SUV (e.g., Rivian R1S SUV)

(Based on EV adoption and vehicle dynamic simulation)

**Diagram:**

- Departure (origin)
- Arrival (destination)
- Time to charge (absolute min + comfort level)
- Waypoint charging (if necessary)
Simulated DC Fast Charging Station Network

- WSEV@Scale boundary
- National parks
- Simulated on-route charging demands
- Required on-route DCFC stations

(Destination charging stations at national parks are not shown)

Gap (miles) Between Simulated DCFC Stations

- 0%
- 5%
- 10%
- 15%

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

- Small: 43%
- Medium: 33%
- Large: 24%

Estimated DCFC ports required: 2,000

DCFC: DC fast charger
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%) vs. general road trips (60%)

### 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.

### Monthly Vehicle Count
- 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.

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).

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

Source: Google
Equity Implications: Rural vs. Urban

- 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.

Summary

● Uniqueness of road trips:
  o Home charging (the dominant form of EV charging) becomes almost irrelevant.
  o Potentially small cohort of vehicle types may be used for road trips (especially for NPS units).
  o Impact of cargo (e.g., roof storage, trailer).

● Estimated required number of charging ports to support electrified road trips in the WSEV@Scale region:
  o On-route DCFC: about 2,000 (not very sensitive to seasonal variations).
  o On-route overnight charging L2 (hotels, etc.): 1,000–2,000.
  o On-site opportunity charging L2: 50–100 (per NPS unit, on average).

● Infrastructure planning:
  o Must be based on summer, winter, or annual average demands?
  o Equity implications—rural vs. urban; mostly benefiting high-income and city residents; gas station business model.
  o Can we develop a “prioritized” strategy as we build out the network over time?
  o Any feedback loop between charging infrastructure (for road trips) and EV adoption?

ADOPT https://www.nrel.gov/transportation/adopt.html
FASTSim https://www.nrel.gov/transportation/fastsim.html
EVI-RoadTrip https://www.nrel.gov/transportation/evi-roadtrip.html
EVI-Equity https://www.nrel.gov/transportation/evi-equity.html