EVI-Pro Model Overview

- Uses daily travel data to estimate EV charging demand
- Designs a charging station network that meets the needs of the region’s travel behavior
- Estimates the resulting impact on the electrical grid over the modeled travel day
- EVI-Pro has been used for studies across the United States and is now expanding to international applications


The Branches:
- Public Destination Charging (right-speeding* for neighborhood, office, retail)
- Public Fast Charging (corridor and community)

The Roots:
- Private Charging (single family, multifamily, workplace)

National Charging Network Supporting 33 Million Light-Duty PEVs by 2030
- 1,067,000 ports (9% of the national investment)
- 182,000 ports (39% of the national investment)
- 26,762,000 ports (52% of the national investment)

*Right-speeding refers to matching the charging power provided at a particular location with the typical duration of the activity.

Each dot represents 50,000 charging ports.
EV Driving / Charging Simulations

Travel Data

<table>
<thead>
<tr>
<th>Departure</th>
<th>Arrival</th>
<th>Destination</th>
<th>Driver A</th>
<th>Driver B</th>
<th>Driver C</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 AM</td>
<td>7:45 AM</td>
<td>Public</td>
<td>None</td>
<td>None</td>
<td>Public DCFC</td>
</tr>
<tr>
<td>9:30 AM</td>
<td>10:30 AM</td>
<td>Public</td>
<td>None</td>
<td>Public L2</td>
<td>None</td>
</tr>
<tr>
<td>12:45 PM</td>
<td>3:00 PM</td>
<td>Public</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>4:00 PM</td>
<td>5:00 PM</td>
<td>Home</td>
<td>Home L2</td>
<td>Home L2</td>
<td>None</td>
</tr>
</tbody>
</table>

Sample Vehicle / Infra Assumptions:
- 250-mile BEV
- DCFC = 150kW
- L2 = 7.2kW

Sample Choice / Access Assumptions:
- Charge every night, home dominant
- Plug-in only if needed, even at home
- No home-charging, reliant on public infrastructure

Simulated Charge Events

Charging demand to satisfy travel
Model Inputs and Outputs

Orange boxes indicate data inputs provided by Bogotá

PEV Fleet Size
Based on 2019 registration data and annual projected EV sales in Bogotá

Driving Behavior

GPS Data
Inferred from survey origin/destination routing

Travel Surveys

PEV Attributes
Assumed

Cost of Charging
Assumed

Residential Access
Based on parking data from survey

3rd Party Data/Simulations
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- **PEV Fleet Size**: Based on 2019 registration data and annual projected EV sales in Bogotá

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- **Driving Behavior**
  - **GPS Data**: Inferred from survey origin/destination routing

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- **Charging Behavior**
  - **Direct Enumeration**
  - **Discrete Choice Models**

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- **PEV Attributes**: Assumed

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- **Cost of Charging**: Assumed
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- **Charging Demand**
- **Installation Considerations**
- **EVI-FAST + URDB**

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Network Design
- Hierarchical Clustering
- Utilization Data

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PEV Attributes
Assumed
Model Inputs and Outputs

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- **Results**
  - Stations
  - Plugs
  - Utilization
  - Load Profiles

- **EVI-Pro**
  - Direct Enumeration
  - Discrete Choice Models
  - Hierarchical Clustering
  - Utilization Data

- **Network Design**
  - Installation Considerations
  - EVI-FAST + URDB

- **Charging Behavior**
  - Charging Demand

- **Driving Behavior**
  - GPS Data
    - Inferred from survey origin/destination routing
  - Trip Data

- **PEV Attributes**
  - Assumed

- **Cost of Charging**
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  - Based on parking data from survey

- **Network Design**
  - Based on 2019 registration data and annual projected EV sales in Bogotá

- **PEV Fleet Size**
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- **3rd Party Data/Simulations**
Applying EVI-Pro to the Bogotá context was made possible by the extensive 2019 travel survey which includes several key inputs for the model:

- **Urban socioeconomic data**: Household, person, and vehicle datasets
  - Household income, house ownership, vehicle registration, parking
- **Travel data**: 17,000 trips split by vehicle type
  - Origins and destinations (at the transportation analysis zone level)
  - Trip start and end times
  - Expansion factor estimated per trip to expand data to 16 million trips
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Sample Weekday and Weekend EV Charging Load Profile Outputs

Primary model outputs include:
- Electricity load profile from EV charging
- **Number** and **type** of charger for each region
- Average charger utilization for each region

*Note difference in y axis scales*
• Created a user-friendly interface for running EVI-Pro with a simplified set of useful inputs

• The NREL team worked with stakeholders in Bogotá to train them in the use of the EVI-Pro model and interpretation of results

• Next steps are for Colombia to run scenarios of interest with NREL as an advisory resource to provide input as needed

• Scenarios can vary any inputs to the model such as home charging availability, future EV adoption estimates, electricity prices, battery size, and daily driving patterns
EVSE Mapping Analysis

Scenario-based mapping analysis to identify locations for near-term buildout of charging stations based on travel data and likelihood of early EV adoption - complements EVI-Pro modeling analysis.

Mapping Analysis Inputs:
- Car Origin/Destinations
- Household Income and Ownership
- Vehicle Registration
- Road Network
- Existing Chargers
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Scenario Output
- Current EV Chargers
- EV Charger Coverage
- Base Scenario Locations
Adapting EVI-Pro: Data needs

**Travel Data**
- Individual vehicle days (from trips) from travel survey or GPS data
- Origin and destination locations
- Start and end times of trips
- Trip motive (destination type - home, work, public)

**Consumer/Vehicle Data**
- Household ownership estimates
- Vehicle ownership
- Electricity/Charging costs (home and public at varying power levels)
- Future EV sales projections
Adapting EVI-Pro: Data needs

**Travel Data**
- a. Individual vehicle days (from trips) from travel survey or GPS data
- b. Origin and destination locations
- c. Start and end times of trips
- d. Trip motive (destination type- home, work, public)

**Consumer/Vehicle Data**
- a. Household ownership estimates
- b. Vehicle ownership
- c. Electricity/Charging costs (home and public at varying power levels)
- d. Future EV sales projections

The travel data is a critical input and must be representative of travel in the region. Datasets used for past analyses have had 10,000+ trips. NREL’s OpenPATH can be used for data collection: https://www.nrel.gov/transportation/openpath.html
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Regional disaggregation for each data type is key to include location information for station buildout.
EVI-X Suite of Tools

Tools to analyze different aspects of EV charging:

- Site design
- Finance
- Charging demand from heavy-duty vehicles, fleets, on-demand ride-hailing
- Long distance trips
- Equity considerations
Work with us
NREL is experienced in working with international stakeholders on a range of projects related to sustainable transportation and the energy transition

Reach Out- if you are interested in learning more about how the EVI-X suite could be applied in your region to aid in planning for vehicle electrification

www.nrel.gov

Thank You
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Tools and Links
• EVI-Pro: https://www.nrel.gov/transportation/evi-pro.html
• EVI-X Suite: https://www.nrel.gov/transportation/evi-x.html
• OpenPath: https://www.nrel.gov/transportation/openpath.html
• NREL International portfolio: https://www.nrel.gov/international/
• NREL-USAID Partnership: https://www.nrel.gov/usaid-partnership/