



NREL Electric Vehicle Infrastructure Projection Modeling in Bogotá Colombia

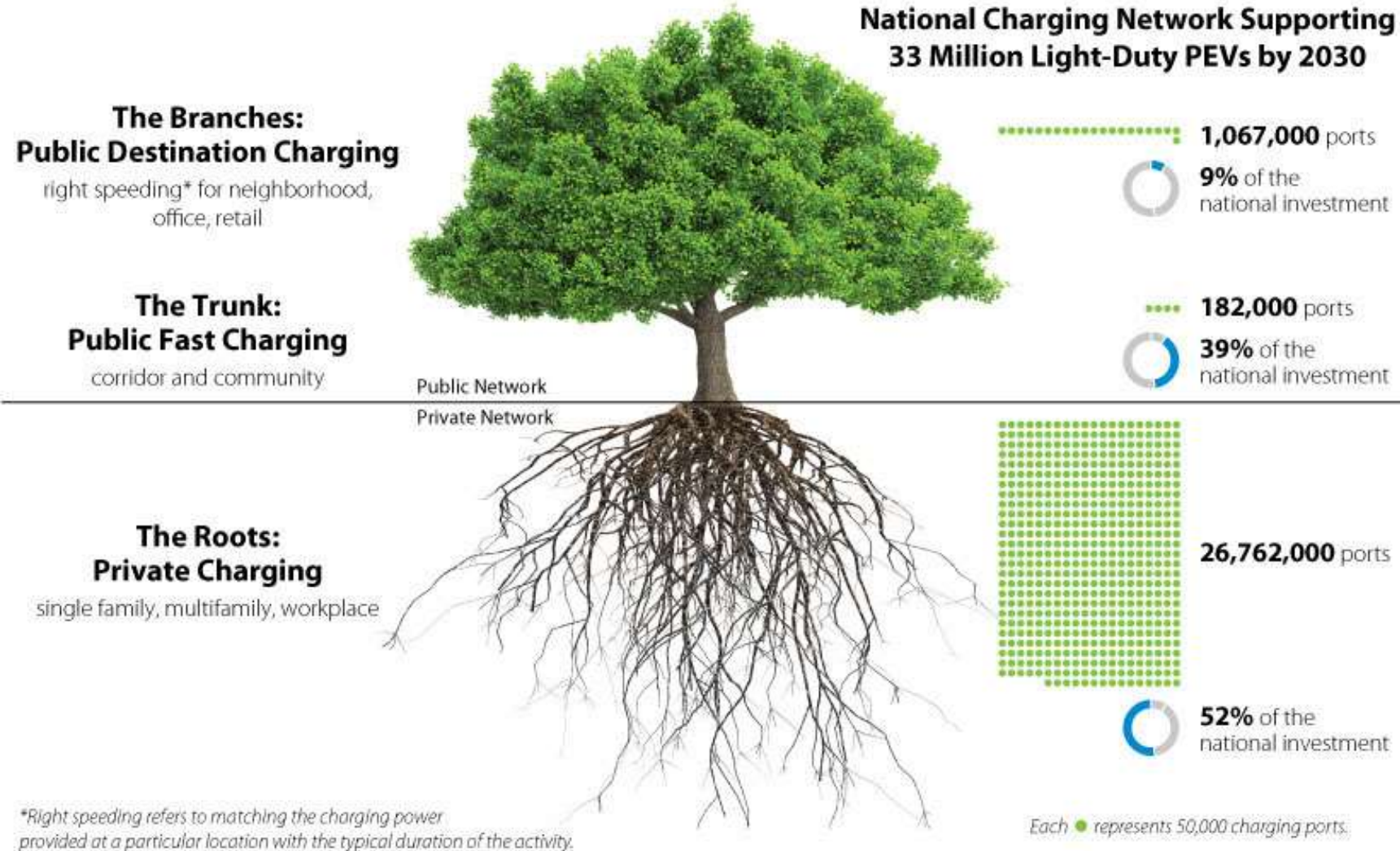
Dustin Weigl
8/31/23

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 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure



EV Driving / Charging Simulations

Travel Data

Simulated Charge Events

Departure	Arrival	Destination	Driver A	Driver B	Driver C
7:00 AM	7:45 AM	Public	None	None	Public DCFC
9:30 AM	10:30 AM	Public	None	Public L2	None
12:45 PM	3:00 PM	Public	None	None	None
4:00 PM	5:00 PM	Home	Home L2	Home L2	None

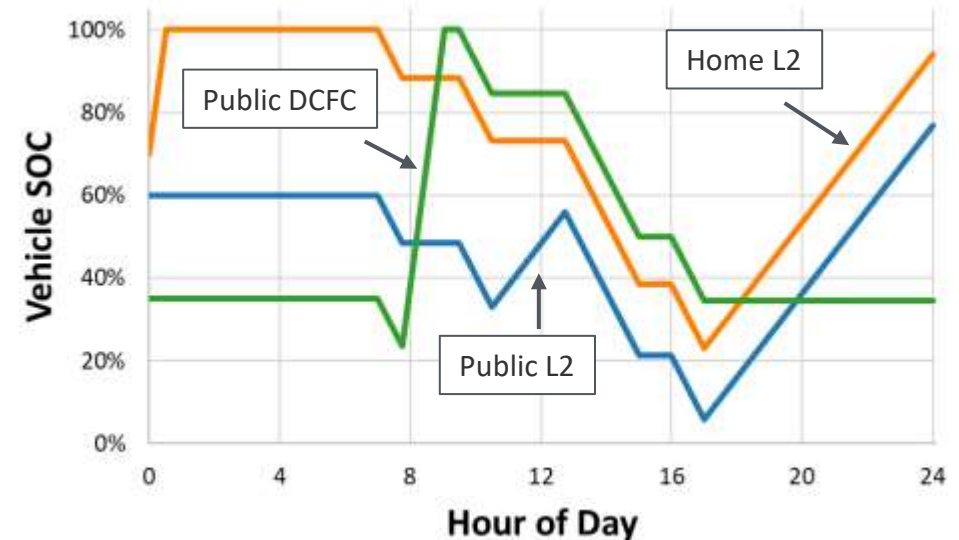
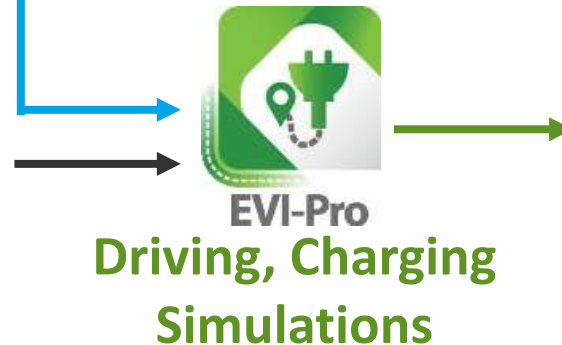
Charging demand to satisfy travel

Sample Vehicle / Infra Assumptions:

- 250-mile BEV
- DCFC = 150kW
- L2 = 7.2kW

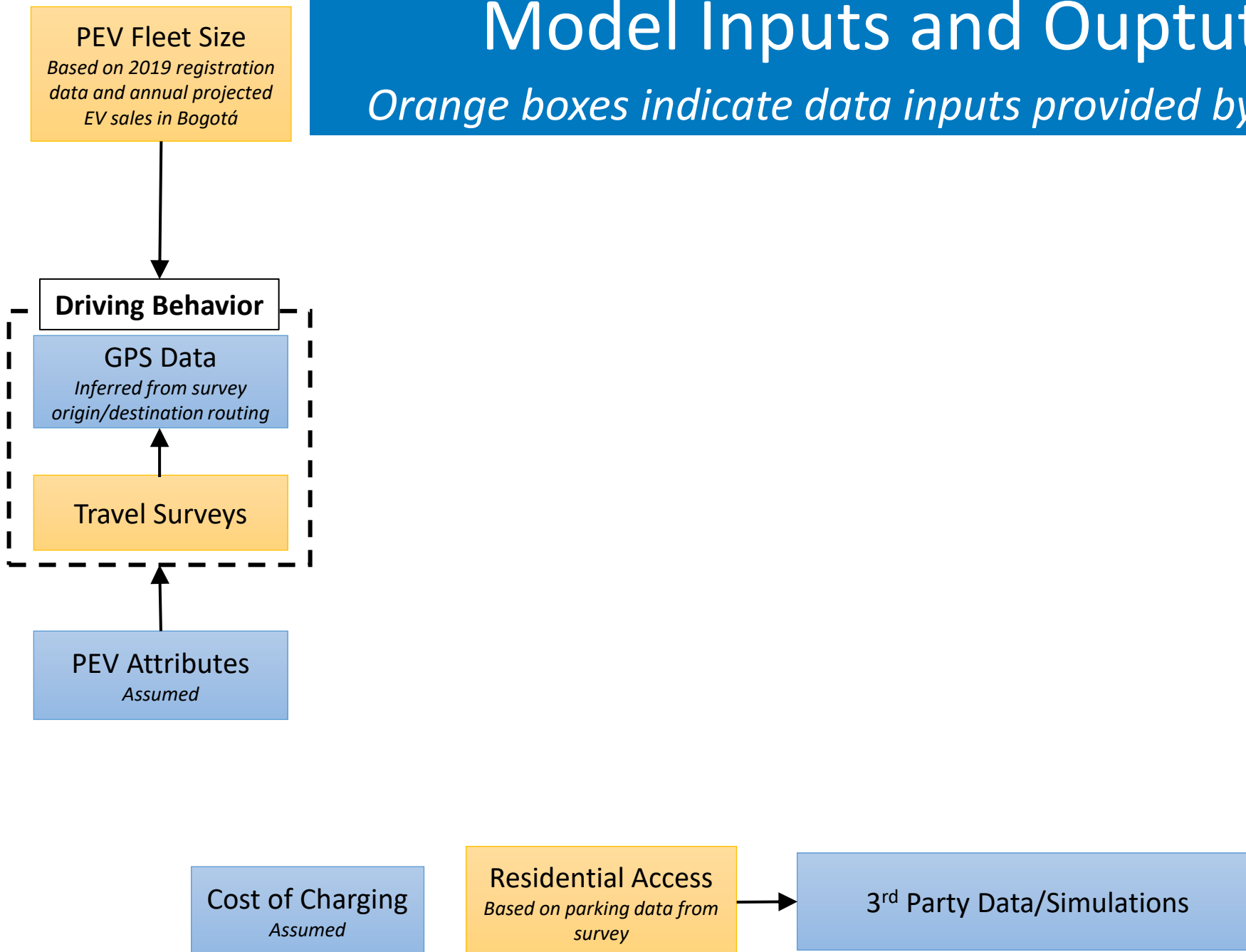
Sample Choice / Access Assumptions:

- Charge every night, home dominant
- Plug-in only if needed, even at home
- No home-charging, reliant on public infrastructure



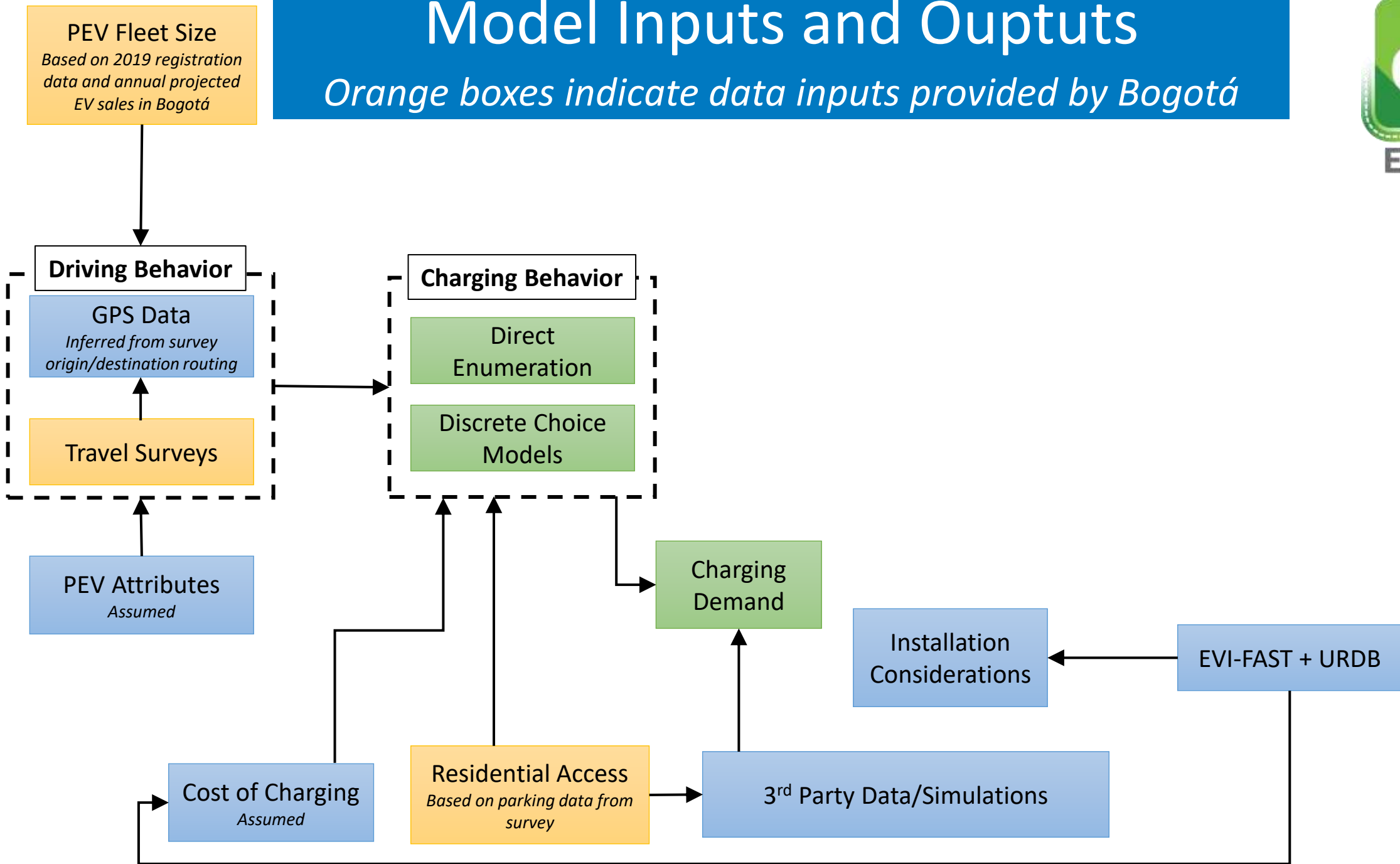
Model Inputs and Outputs

Orange boxes indicate data inputs provided by Bogotá



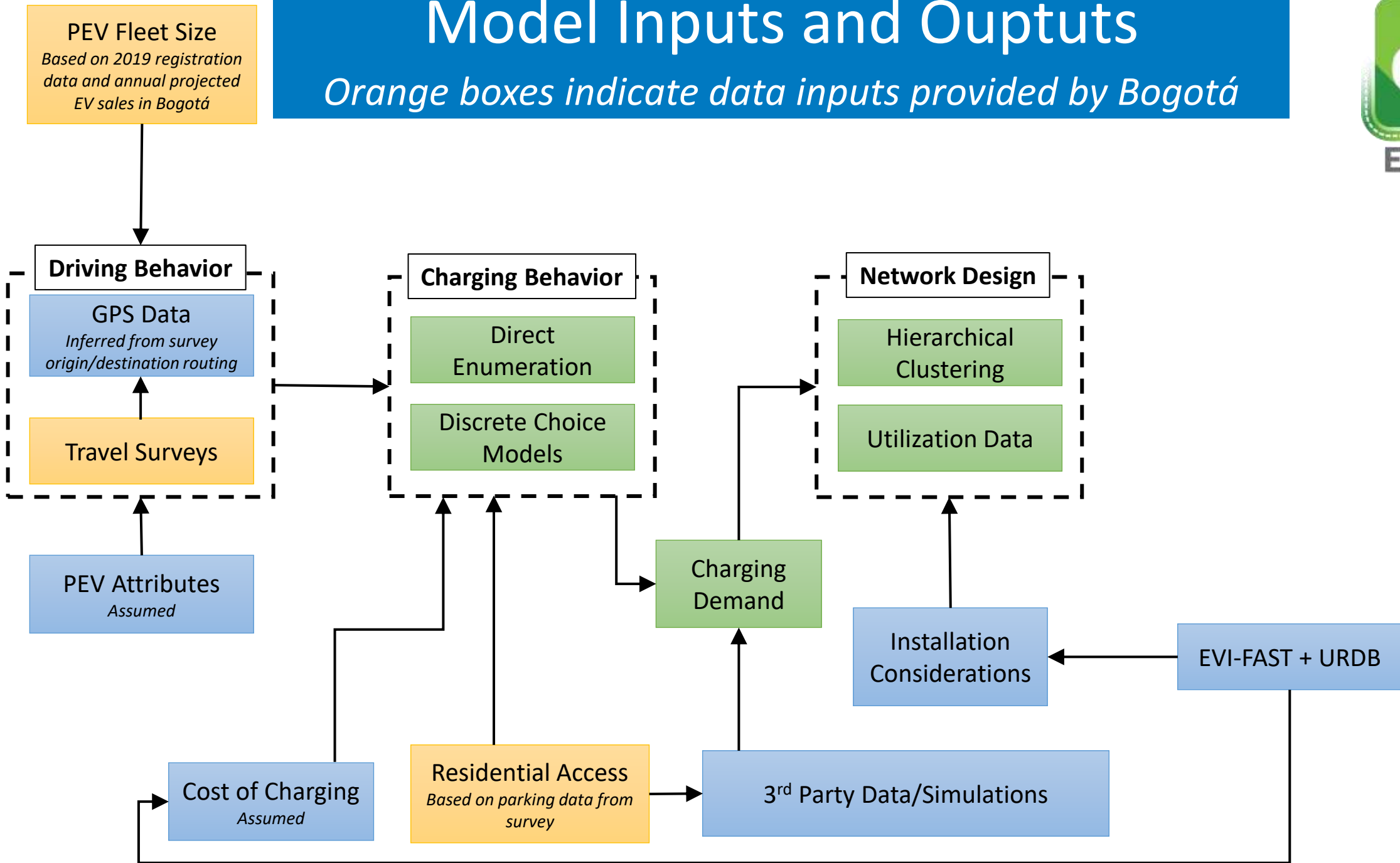
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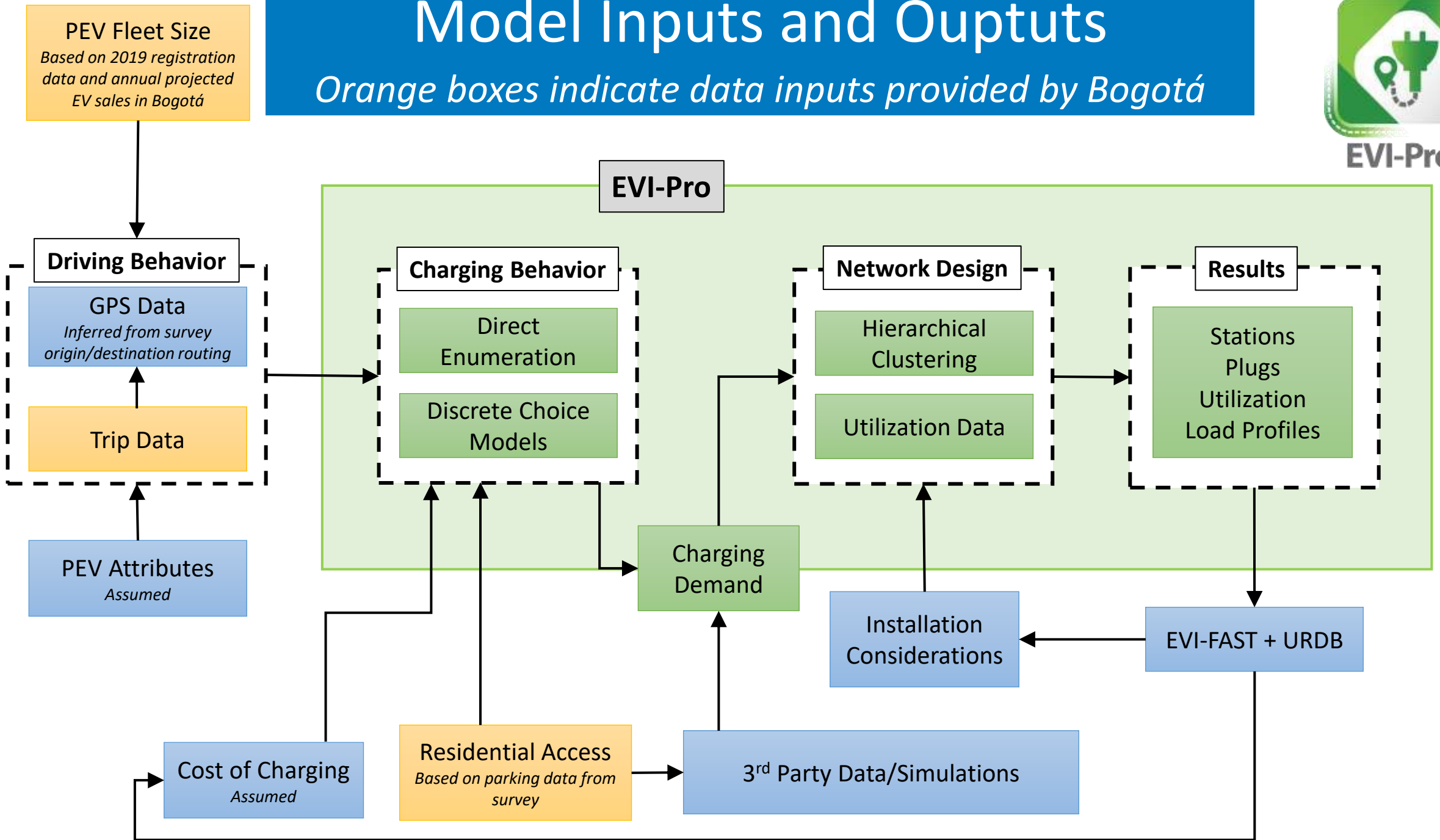
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EVI-Pro and EVSE Analysis for Bogotá Colombia

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

EVI-Pro Model: Charging Station Analysis for Bogotá Colombia

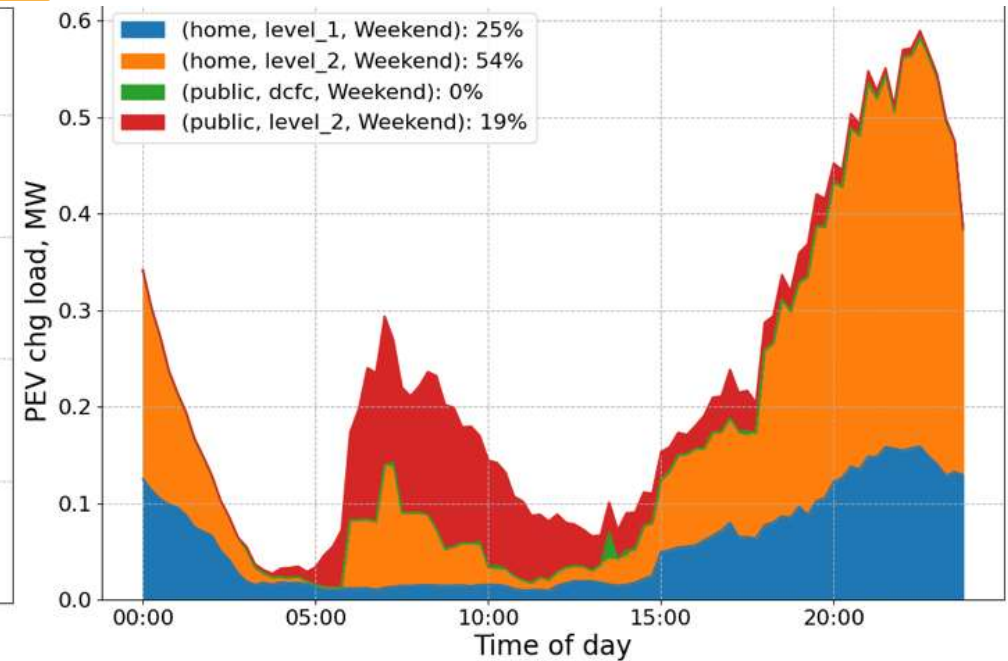
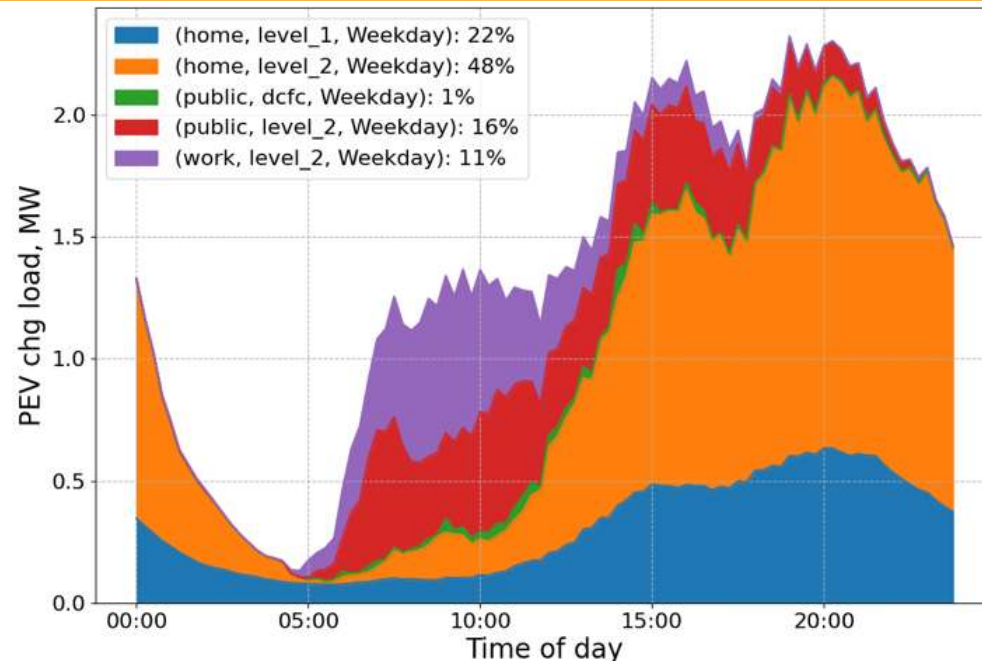
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Primary model outputs include:

- Electricity **load profile** from EV charging
- **Number** and **type** of charger for each region
- Average **charger utilization** for each region

Sample Weekday and Weekend EV Charging Load Profile Outputs



*Note difference in y axis scales

EVI-Pro Interface

- 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

The screenshot shows the 'EVI Pro Colombia' web interface. At the top, it says 'Welcome to EVI Pro Colombia' and features logos for Grupo Energía Bogotá, the U.S. Department of Energy, and NREL. The main section is divided into two columns: BEV and PHEV. The BEV column has input fields for Battery Capacity kWh (60.0), Watt Hour Per Mile (230), Gasoline Capacity (Gallons) (NaN), Miles Per Gallon (NaN), Max Charge AC kW (15), and Max Charge DC kW (150). The PHEV column has input fields for Battery Capacity kWh (10.7), Watt Hour Per Mile (375), Gasoline Capacity (Gallons) (9999.0), Miles Per Gallon (49.0), Max Charge AC kW (15), and Max Charge DC kW (0). To the right, there is a 'Fleet Population Year' section with a text prompt and a text input field containing '2025'. Below these sections, there are two checked checkboxes: 'Run Charging Simulation' and 'Run Network Sizing'. At the bottom, there are two text input fields: 'Enter Simulation Name: Sample Simulation Run' and 'Enter Network Name: Sample Network Run'. Finally, there are two large buttons: 'Save and Run' and 'Exit'.

	BEV	PHEV
Battery Capacity kWh	60.0	10.7
Watt Hour Per Mile	230	375
Gasoline Capacity (Gallons)	NaN	9999.0
Miles Per Gallon	NaN	49.0
Max Charge AC kW	15	15
Max Charge DC kW	150	0

Fleet Population Year: 2025

Run Charging Simulation Run Network Sizing

Enter Simulation Name: Sample Simulation Run Enter Network Name: Sample Network Run

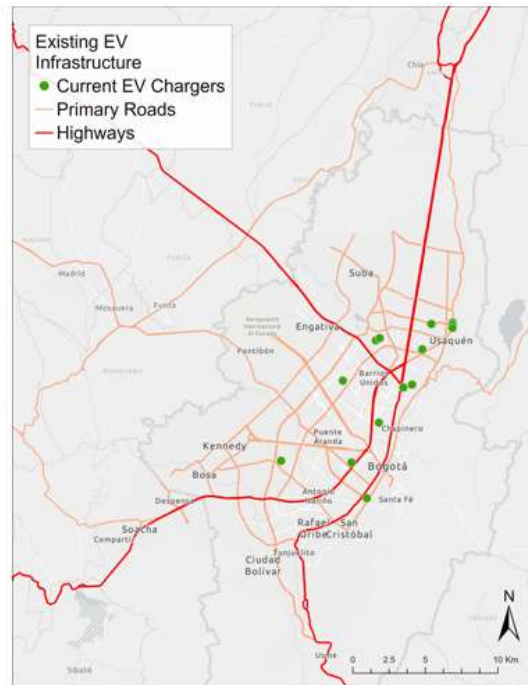
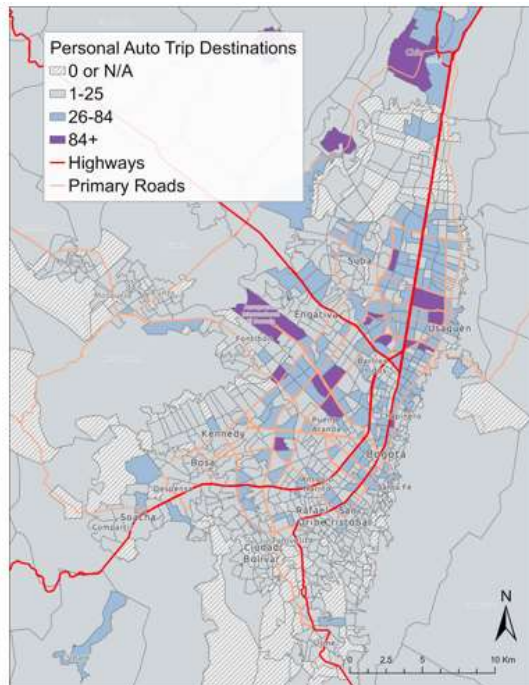
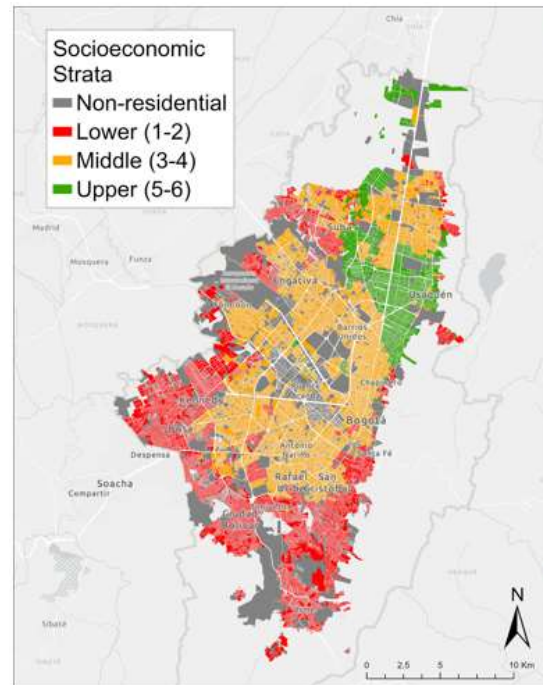
Save and Run Exit

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



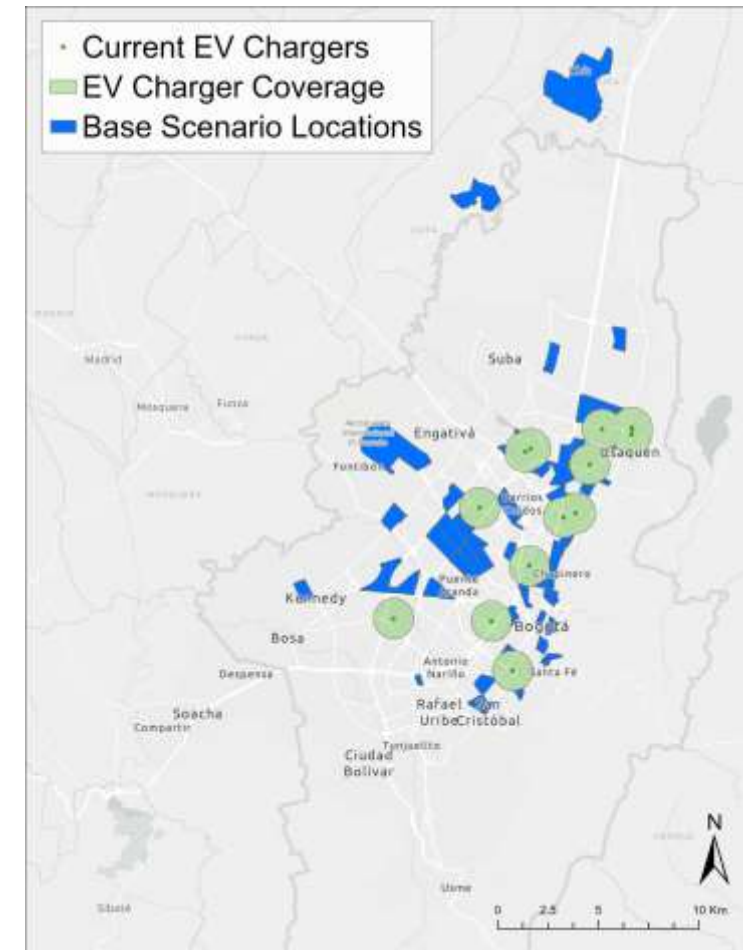
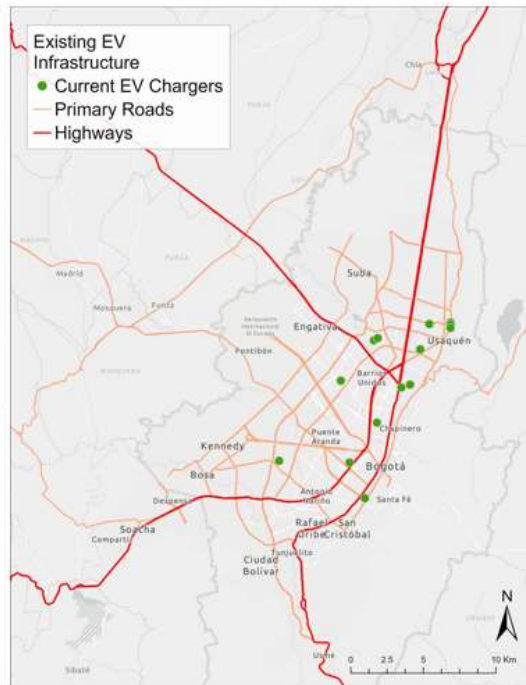
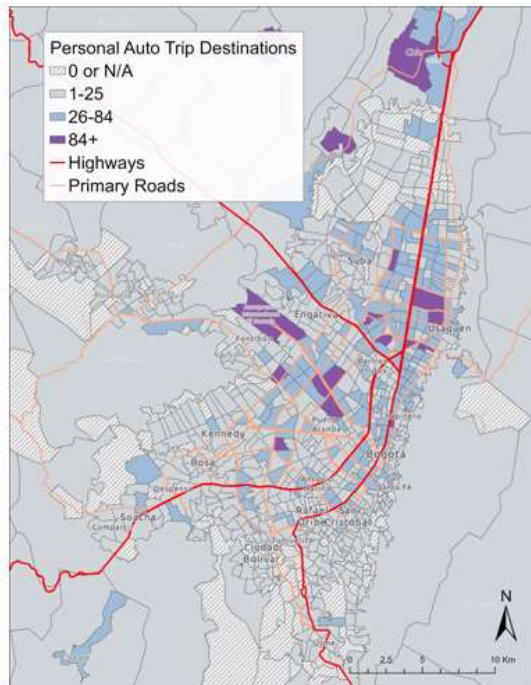
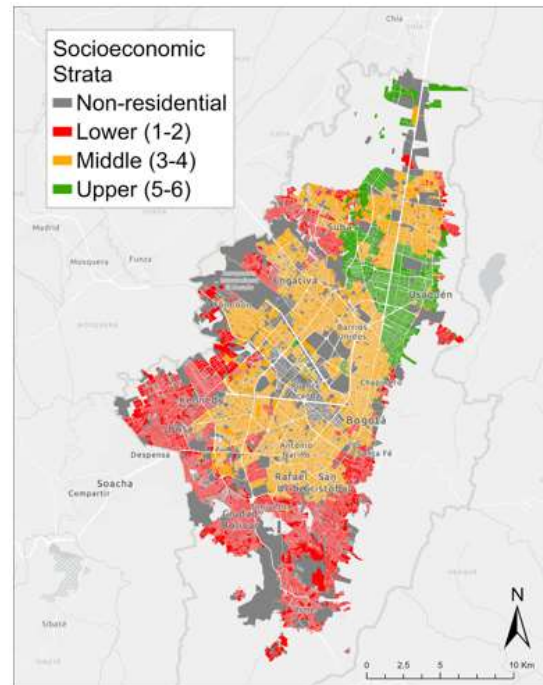
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Scenario Output



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)

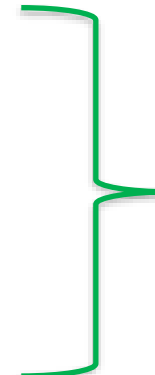
Consumer/Vehicle Data

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

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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




Network Planning


EVI-Pro > 
Charging infrastructure projection based on typical daily travel

EVI-Pro Lite > 
Simplified version of EVI-Pro (free to use)

EVI-Equity > 
Charging infrastructure accessibility from environmental-justice perspective

EVI-OnDemand (GitHub) > 
Charging infrastructure demand modeling for ride-hailing services

EVI-Pro HD 
Depot and corridor charging infrastructure projection for commercial vehicles

EVI-RoadTrip > 
Charging infrastructure analysis for long-distance travel



Site Design

EVI-InMotion > 
Dynamic and quasi-dynamic charging infrastructure design

EVI-EnSite > 
Charging infrastructure energy estimation and site optimization


EVI-EDGES > 
Design and use optimization for behind-the-meter storage

EVI-Fleet 
Operational and economic analysis for fleet electrification

HEVII 
Multi-fidelity telematics-enabled vehicle and infrastructure design



Financial Analysis

EVI-FAST > 
Charging infrastructure financial analysis

EVI-FAST can integrate with all the tools listed above

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/usaaid-partnership/>

