EVI-X modeling suite accelerates optimized electric vehicle charging infrastructure deployments

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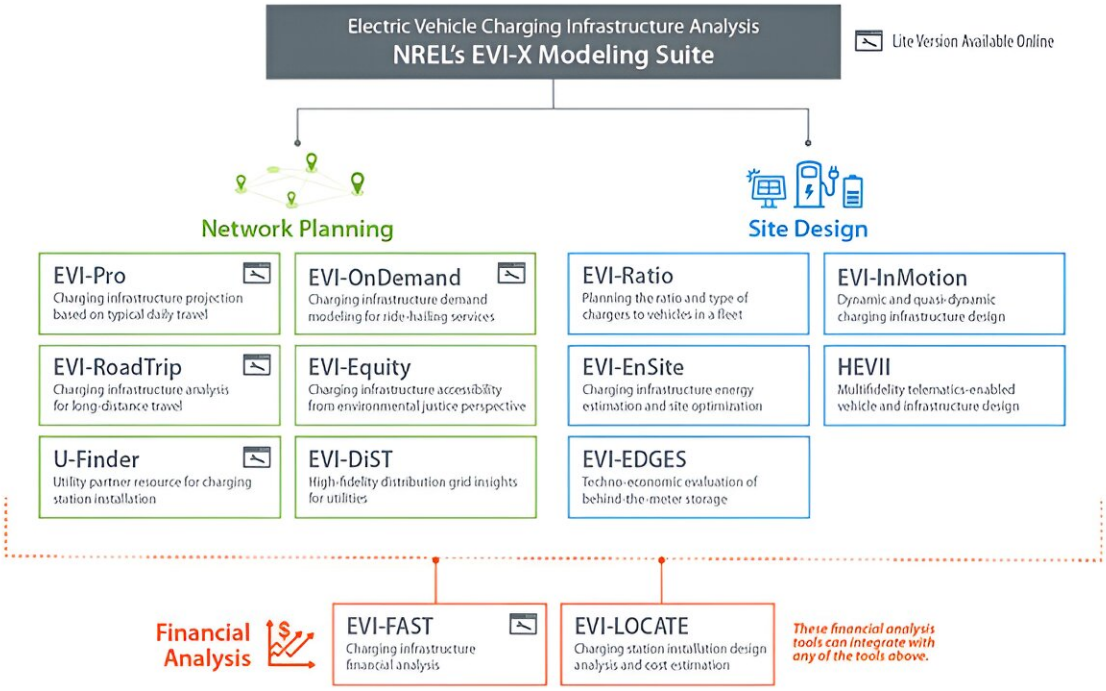

The EVI-X suite is comprises three types of tools—network planning, site design, and financial analysis—to inform strategic EV charging infrastructure deployments. Credit: Cameron Nelson, NREL

Massive public and private investments are being made to support the buildout of electric vehicle (EV) charging infrastructure in the United

States, but efficient planning and deployment requires sophisticated analysis to ensure convenient, reliable, affordable, and equitable charging for all Americans.

This is where the National Renewable Energy Laboratory (NREL) comes in. Leveraging its decades of EV charging infrastructure expertise, the laboratory developed the EVI-X Modeling Suite of EV Charging Infrastructure Analysis Tools, the most sophisticated and comprehensive set of integrated charging infrastructure analysis tools available today.

"Each tool in the EVI-X modeling suite shares the same philosophy: to accelerate convenient and affordable EV adoption by lowering every possible barrier to EV charging infrastructure deployment," said NREL's Eric Wood, a senior EV charging infrastructure researcher who plays a key role in developing and refining the suite.

"We've added everything we understand about human behavior and charging preferences to simulate what an EV charging network should look like to meet peoples' needs, whether they drive a small sedan or a heavy-duty tractor trailer."

"We take the stance that EV adoption needs to be a no-compromise solution," he continued. "EV charging, as we see it, should be easy, convenient, and never fail to meet drivers' needs."

In addition to identifying the necessary number and type of EV chargers—ranging from fast, high-power public charging stations to slower, Level 1 (120 volts AC) and Level 2 (208–240 volts AC) charging ports—to support large-scale EV adoption, the EVI-X suite enables researchers, partners, and others to pinpoint locations best suited for EV charging station installation, estimate associated costs and charging loads, and develop optimal solutions for effective integration—all before

monetary and time investments are made.

"While some of the tools in the EVI-X suite were developed years ago, others are relatively new," Wood said.

"Originally, each tool in the suite was developed independently, but as they matured, we began to realize that linking them together would enable us to answer deeper questions. And today, we can even link tools in the EVI-X suite with other tools in NREL's portfolio to explore EV adoption scenarios, power systems modeling, and more."

The EVI-X suite has the unparalleled ability to answer the most complex questions addressing every aspect of EV charging—from network planning and site design to financial analysis—for every vehicle weight class—from sedans and SUVs to delivery vans, buses, freight trucks, and more—and at wide-ranging geographic scales—from a small town to the entire nation. Because it is agile enough to account for changing variables, such as improving EV technologies and growing consumer adoption, the EVI-X suite can provide accurate EV charging analysis for today and in the decades to come.

Three types of tools in the EVI-X suite

The tools in the EVI-X suite fall into three crosscutting categories:

- Network planning tools to quantify EV charging infrastructure needs such as the number, type, and location of charging ports to support different levels of EV adoption; recommended power levels; the potential grid impacts of increasing EV adoption, plus strategies to lessen stress on the grid; accessible and affordable charging; optimized charging for fleets and ride-hailing services; long-distance travel along highway corridors; and finding utility partners for infrastructure installation

- Site design tools to inform EV charging station designs related to energy estimation and site optimization; composition and size of EV fleets; placement of charging station equipment; sizing and control of behind-the-meter energy storage; and the feasibility of dynamic roadway charging
- Financial analysis tools to assess costs associated with EV charging infrastructure such as station and network economics, the levelized cost of charging, and investor payback period and risk analyses.

Research-grade EVI-X tools enable complex analyses

Powered by NREL's world-class high-performance computing and simulation capabilities, the EVI-X suite is comprised of research-grade tools as well as publicly accessible, simplified versions of select tools.

The suite's research-grade tools are used by NREL researchers in powerful computing environments to conduct multifaceted analyses:

- The Electric Vehicle Infrastructure—Projection Tool (EVI-Pro) estimates the quantity and type of chargers needed to meet a given demand and identifies associated power demands on the electric grid. It accounts for differences in vehicle and charger technologies, market adoption conditions, the shared use of chargers, and travel and charging preferences.
- The Electric Vehicle Infrastructure for Road Trips Tool (EVI-RoadTrip) simulates the optimal number and location of charging stations and associated power demands on the electric grid to enable long-distance travel along interregional highway corridors.
- The Electric Vehicle Infrastructure—In Motion Tool (EVI-InMotion) analyzes the feasibility and optimization of dynamic chargers on public roadways and evaluates their impact on vehicle efficiency, driving range, and charging time.

- The Electric Vehicle Infrastructure—Energy Estimation and Site Optimization Tool (EVI-EnSite) informs the design, development, and control of optimized charging infrastructure deployments and station operations.
- The Electric Vehicle Infrastructure—Enabling Distributed Generation Energy Storage Model (EVI-EDGES) configures cost-effective behind-the-meter energy storage and distributed energy generation systems based on the climate, building types, and utility rate structures associated with potential EV charging infrastructure sites.
- The Heavy-Duty Electric Vehicle Integration and Implementation Tool (HEVII) evaluates the electrification potential and infrastructure requirements for commercial vehicle fleets. It provides customized specifications and recommendations for optimal vehicle battery sizes, charging rates, and infrastructure placements.
- The Electric Vehicle Infrastructure for Equity Model (EVI-Equity) evaluates the accessibility, affordability, and decarbonization benefits of EVs and charging infrastructure and provides high-resolution data for designing equitable EV charging infrastructure deployments.
- The Electric Vehicle Infrastructure—Ratio Tool (EVI-Ratio) identifies the number of fleet vehicles likely to transition to EVs in the next vehicle replacement cycle and determines related charging infrastructure requirements.
- The Electric Vehicle Infrastructure—Distribution System Integration Tool (EVI-DiST) provides high-fidelity modeling to utility planners, allowing for better monitoring and control of increased EV charging loads.

Publicly available EVI-X tools offer easy access

To provide policymakers, utilities, businesses, and all levels of

government with free access to best-in-class EV charging infrastructure insights, many EVI-X tools have been made available to the public. These tools can inform optimized, cost-effective planning and deployment of new EV charging infrastructure and the grid upgrades needed to support them.

- The Utility Finder for Identifying EV Infrastructure Installation Partners (U-Finder) is a simple online tool that enables people to find information about utilities supporting EV charging infrastructure installations in a given state or ZIP code as well as related rebates and incentives offered by utilities.
- The Electric Vehicle Infrastructure—On Demand Tool (EVI-OnDemand) is an open-source modeling and simulation resource, accessible via GitHub, for estimating the charging infrastructure requirements of electrified ride-hailing fleets in urban areas.
- The Electric Vehicle Infrastructure—Financial Analysis Scenario Tool (EVI-FAST) provides quick, in-depth financial analyses informed by infrastructure characteristics such as charger power ratings, usage, cost, and incentives as well as parameters such as electricity prices and demand charges.

Lite versions of EVI-X tools feature intuitive online interfaces

Simplified versions of some of the tools in the EVI-X suite are available as online tools that provide fast, powerful insights to users without requiring in-depth technical knowledge or high-performance computing power.

For example, the recently launched EVI-RoadTrip Lite tool is a streamlined version of EVI-RoadTrip. The full-scale version of EVI-RoadTrip is primarily accessible to researchers via proprietary software

and extensive computational resources. But now, with EVI-RoadTrip Lite, anyone can access the web version of the tool to gain insight into optimized EV charging infrastructure installations along major travel corridors.

"Corridor charging stations, primarily located along highways in rural locations, are critical for enabling widespread EV adoption, giving drivers confidence in traveling beyond the cities and towns where they live," said NREL's Lauren Spath Luhring, a senior researcher and software developer who helped create the tool.

EVI-RoadTrip Lite builds on the success of EVI-Pro Lite, a simplified version of EVI-Pro that features two tools in one: a daily charging-need tool for estimating how much EV charging infrastructure is needed to support typical daily travel in a given state or metropolitan area, with an option for ride-hailing applications; and a load profile tool for estimating power demands on the electric grid for typical daily charging in a given state or city.

"The addition of EVI-RoadTrip Lite to our collection of publicly accessible 'lite' tools enables users to gain a more complete picture of charging needs and associated power demands for local daily charging and long-distance road trips," Spath Luhring added.

"Available to anyone with access to the internet, these tools are utilized by local communities, state policymakers, utility companies, fleet operators, vehicle manufacturers, EV charging station operations, and the general public alike."

Strategic partnerships result in historic impacts

The EVI-X suite enables NREL researchers to conduct customized analyses in collaboration with government entities, vehicle

manufacturers, charging network operators, electric utilities, public utility commissions, research institutions, and more.

In the last few years alone, NREL researchers have worked closely with an array of federal agencies including the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Joint Office of Energy and Transportation.

NREL has also partnered with state agencies and research institutions including the California Energy Commission, the New York State Energy Research and Development Authority, and the Electric Power Research Institute, as well as numerous industry partners.

"The EVI-X suite enables actionable insights at a never-before-seen level of detail," said NREL's Brennan Borlaug, a senior research analyst focusing on EV charging infrastructure. "We have used it to conduct multiple analyses in partnership with federal and state agencies, helping to inform billions of dollars in planned EV charging investments."

For example, NREL researchers tapped into the EVI-X suite to perform analyses supporting the national charging infrastructure provisions of the Bipartisan Infrastructure Law, including the National Electric Vehicle Infrastructure Formula Program.

The Bipartisan Infrastructure Law brought about game-changing legislation representing the largest federal investment in EV charging—with $7.5 billion available for EV charger deployment along highway corridors to facilitate long-distance travel and within communities to provide convenient charging where people live, work, and shop.

In another project, researchers employed tools in the EVI-X suite, in conjunction with NREL's Transportation Energy & Mobility Pathway

Options (TEMPO) Model, to conduct the 2030 National Charging Network Study.This groundbreaking study identified the number, type, and location of chargers needed to create a comprehensive national network of EV charging infrastructure to support an anticipated 30–42 million EVs on the road by 2030.

To guide utility distribution planning for this new charging network, NREL researchers teamed up with Lawrence Berkeley National Laboratory, Kevala, and the U.S. Department of Energy to assess the charging and grid infrastructure needed in five U.S. states illustrative of the nation's diverse travel demands and utility infrastructure.

The first-of-its-kind Transportation Electrification Impact Study estimates the investments in charging and electrical infrastructure needed to support increased EV adoption. It also explores strategies to manage loads and found net benefits to the electric system.

"The fundamental contributions that the EVI-X team has made to the national EV charging infrastructure landscape will outlive any individual study," said Gabriel Klein, executive director of the Joint Office of Energy and Transportation. "They will likely go on to shape public and private infrastructure investments for many years to come."

As new state and national policies drive increasing EV adoption, the EV charging landscape must grow rapidly to support more EVs on the roads. NREL's EVI-X modeling suite is designed to help.

"EVI-X is the most powerful and comprehensive software suite built specifically to help the United States rise to the challenge of building right-sized, cost-effective, and convenient EV charging infrastructure; ensure effective use of private and public investments; and meet the needs of fleets, businesses, utilities, and individual drivers," Wood said.

"Trusted by federal and state agencies and industry partners alike, EVI-X has only just begun to help make affordable, reliable, and equitable EV charging a reality for the nation."

Learn more about NREL's sustainable transportation and mobility research and world-class data and tool resources, including the EVI-X Modeling Suite of EV Charging Infrastructure Analysis Tools.

Provided by National Renewable Energy Laboratory

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