Using the EZMT to Equitably Plan for Electric Vehicle Charging Stations

JAMES KUIPER, XINYI (SYDNEY) WU

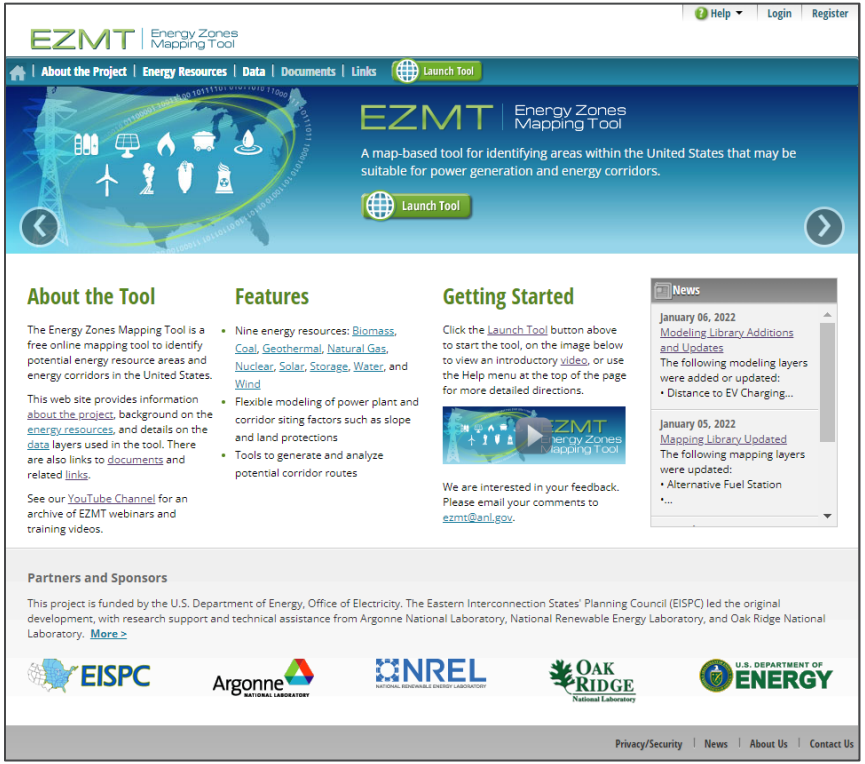
Argonne National Laboratory

U.S. DEPARTMENT OF ENERGY Argonne National Laboratory is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

January 11, 2022

TODAY'S DISCUSSION

- Introduction
- EZMT mapping content
- EZMT modeling methodology
- EVSE/equity examples
- Demonstration
- Questions

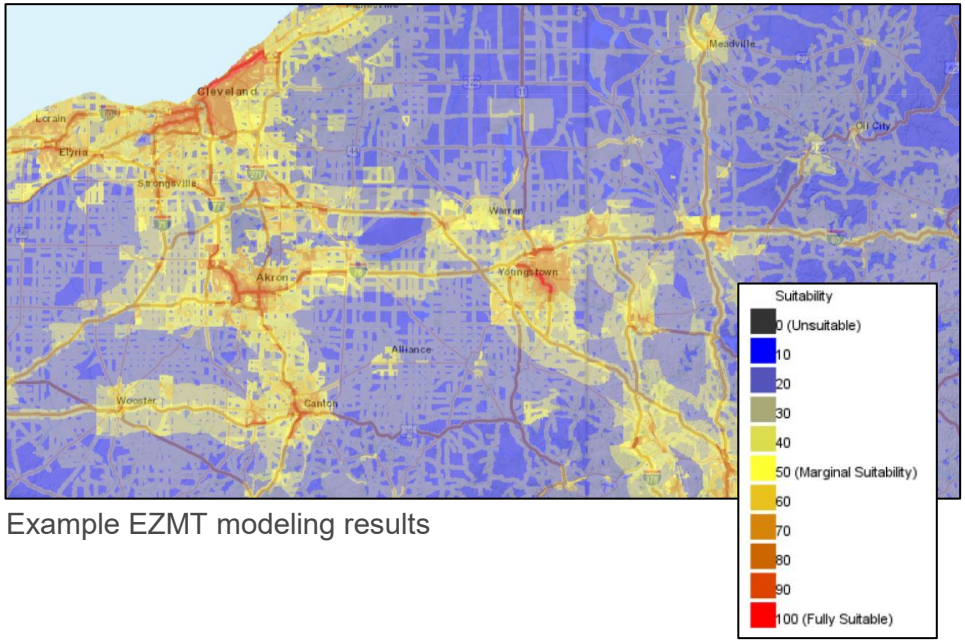


https://ezmt.anl.gov

INTRODUCTION

THE ENERGY ZONES MAPPING TOOL (EZMT) IS A PUBLIC, WEB-BASED MAPPING TOOL

- Funded by the DOE Office of Electricity
- First launched in 2012
- Now updated to help plan new electric vehicle supply equipment (EVSE) locations with an emphasis on equity and environmental justice
- Scope of mapping and analysis capabilities:
  - Energy resources (e.g., wind, solar)
  - Energy infrastructure (e.g., substations, alternative fuel stations)
  - Siting factors (e.g., land use, traffic, population density)
  - Reference data (e.g., boundaries)



Example EZMT modeling results

TODAY THE EZMT IS ALSO BEING USED IN OUR VEHICLE TECHNOLOGIES OFFICE PROJECTS

- Funded by the DOE Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Office
- Mid-Atlantic Electrification Partnership
  - Seeking to advance EV adoption and EVSE network development in Washington DC, Maryland, Virginia, and West Virginia with an emphasis on social equity
- I-80 Mid-America Alternative Fuel Corridor
  - Developing an Alternative Fuels Corridor Deployment Plan for I-80 from Iowa to New Jersey, including EVSE and compressed natural gas stations
- While focused on these projects, EZMT updates have a national extent whenever possible

WHAT QUESTIONS ARE THE EZMT DESIGNED TO ANSWER?

- Where are the current EV corridors and DC Fast charging stations in my area of interest?
- Which electrical service provider owns that substation?
- Where can I obtain a copy of the household transportation energy burden data?
- Where should we prioritize EVSE siting investments to fill gaps along a designated EV corridor?
- What changes if we add equity to the analysis?
- Which of these three potential sites is the best?
- Where might we be able to leverage federal funds to help underserved areas?
- Do the locations we chose meet our equity objectives?
- How much of Ohio's power generation is from renewable sources?

EV INFRASTRUCTURE AND EQUITY ARE FEDERAL PRIORITIES

“goal to accelerate and deploy electric vehicles and charging stations”

The White House. Fact Sheet: Biden Administration Advances Electric Vehicle Charging Infrastructure https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-biden-administration-advances-electric-vehicle-charging-infrastructure.

“the Federal Government should pursue a comprehensive approach to advancing equity for all”

Executive Order No. 13985. Advancing Racial Equity and Support for Underserved Communities Through the Federal Government. Federal Register. Federal Register: Washington, DC 2021, pp 7009–7013.


THE WHITE HOUSE

FACT SHEET: Biden Administration Advances Electric Vehicle Charging Infrastructure

APRIL 22, 2021 • STATEMENTS AND RELEASES

Department of Transportation, Department of Energy, and General Services Administration Announce New Actions to Accelerate Deployment of Electric Vehicles and Chargers

Today, the White House announced new progress on the Administration's goal to accelerate and deploy electric vehicles and charging stations, create good-paying, union jobs, and enable a clean transportation future. This

actions by federal agencies:

- The Department of

on how gra

Executive Order 13985 of January 20, 2021

Advancing Racial Equity and Support for Underserved Communities Through the Federal Government

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered:

Section 1. *Policy.* Equal opportunity is the bedrock of American democracy, and our diversity is one of our country's greatest strengths. But for too many, the American Dream remains out of reach. Entrenched disparities in our laws and public policies, and in our public and private institutions, have often denied that equal opportunity to individuals and communities. Our country faces converging economic, health, and climate crises that have exposed and exacerbated inequities, while a historic movement for justice has highlighted the unbearable human costs of systemic racism. Our Nation deserves an ambitious whole-of-government equity agenda that matches the scale of the opportunities and challenges that we face.

It is therefore the policy of my Administration that the Federal Government should pursue a comprehensive approach to advancing equity for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality. Affirmatively advancing equity, civil rights, racial justice, and equal opportunity is the responsibility of the whole of our Government. Because advancing equity requires a systematic approach to embedding fairness in decision-making processes, executive departments and agencies (agencies) must recognize and work to redress inequities in their policies and programs that serve as barriers to

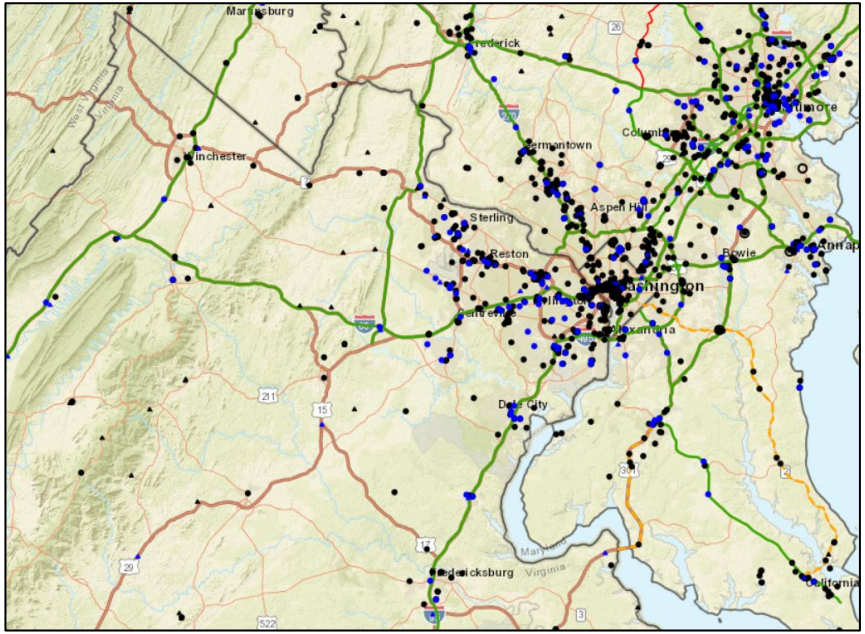
Equity has many dimensions. Identifying metrics and how best to serve the needs and interests of underserved communities are being studied. The equity-related examples in this presentation are for illustration purposes only.

EZMT MAPPING CONTENT

EV AND TRANSPORTATION MAPPING LAYERS IN THE EZMT

Mapping layers can be **viewed** and **queried** on the map, and **downloaded**

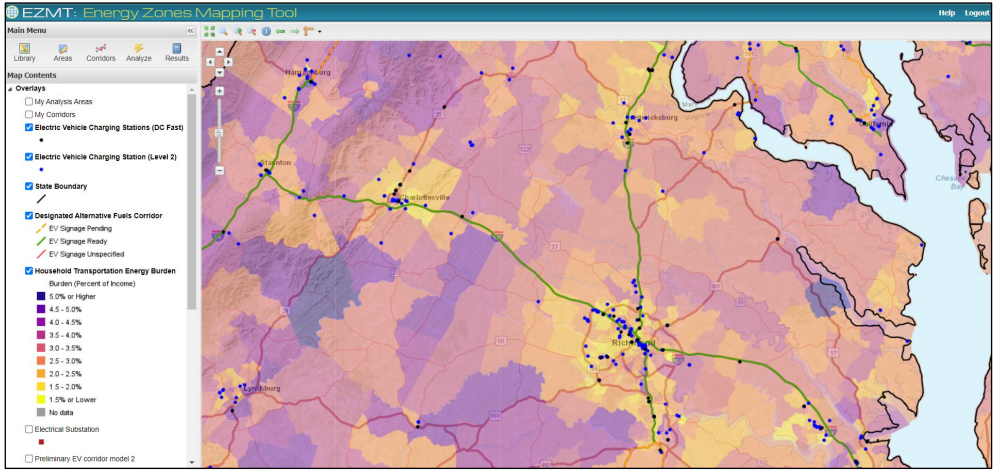
- Airports
- Alternative Fuel Stations (All categories)
- Average Annual Daily Vehicle Traffic
- Designated Alternative Fuel Corridors (Round 5)
- Electric Vehicle Charging Stations (Tesla/Non-Tesla, DC Fast/Level 2, and Planned)
- Major Roads
- Marine Ports
- Public Transit Stop Density



Designated EV corridors and EV charging stations in the Washington DC area

EQUITY MAPPING LAYERS IN THE EZMT

- EPA EJScreen 2020 (includes 28 equity metrics)
- EPA Class I Areas
- Household transportation energy burden
- Households without vehicles
- Housing – Units in multi-unit structures
- Housing – Mobile home units
- HUD opportunity zones
- Low-income percentage
- Minority percentage
- National air quality standard areas (7 types)
- Population density
- Rural areas
- Transit desert index
- Tribal reservation



Household transportation energy burden with EV charging stations and designated EV corridors in the EZMT

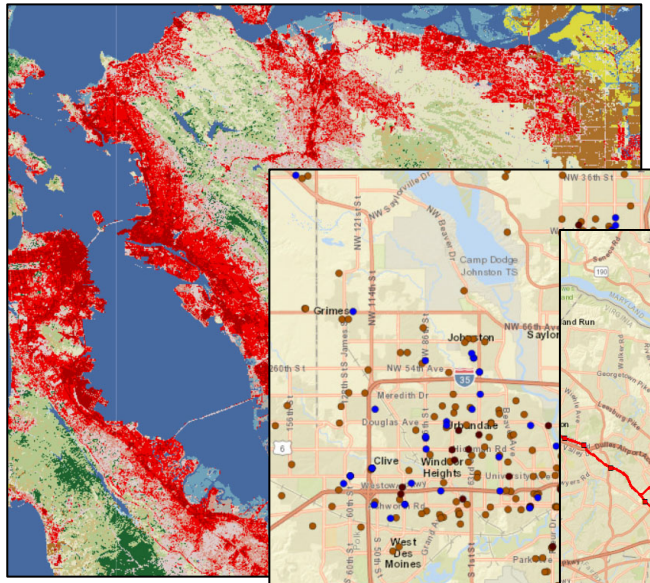
Mapping layers can be **viewed** and **queried** on the map, and **downloaded**

OTHER RELEVANT EZMT MAPPING LAYERS

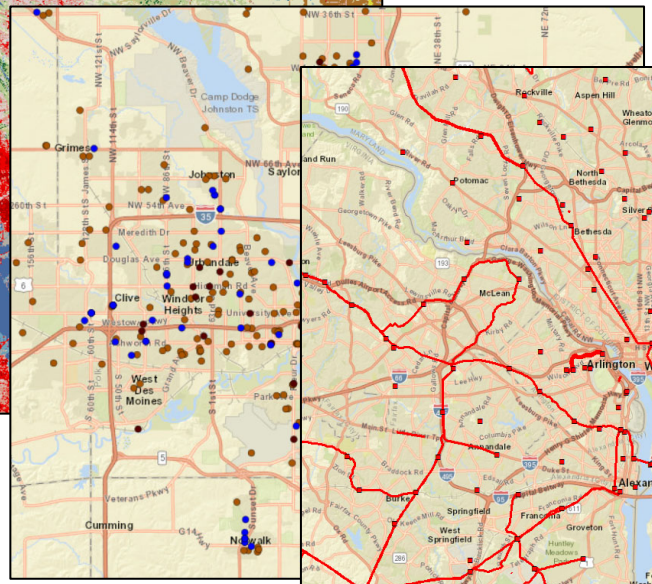
- Electrical substations
- Electrical transmission lines
- Electric power retail service territories
- Power plants
- Land cover
- National parks
- Schools, colleges, universities, hospitals
- Many others…

The EZMT mapping library currently has over 350 layers

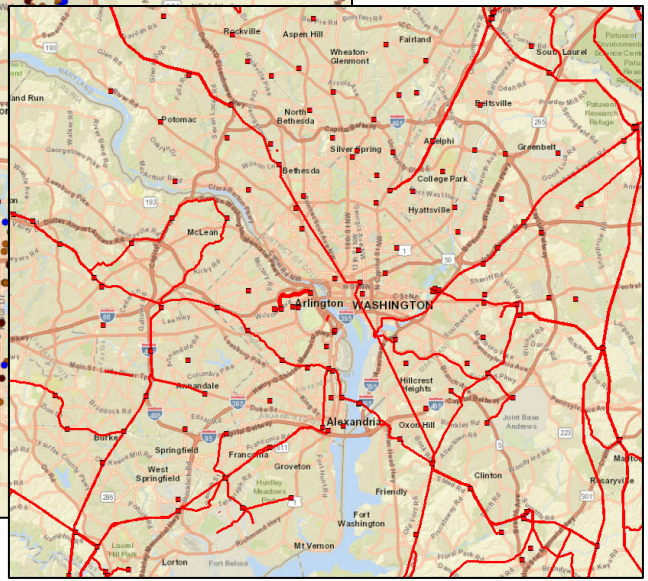
Mapping layers can be **viewed** and **queried** on the map, and **downloaded**



Land cover



Schools, colleges, universities, hospitals



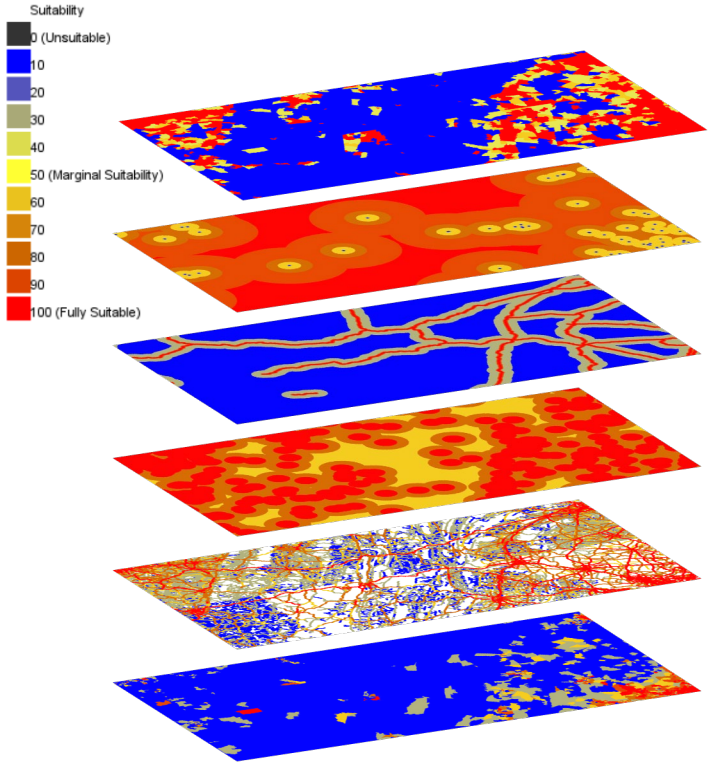
Transmission lines and substations

EZMT MODELING METHODOLOGY

(Suitability modeling, or multi-criteria decision analysis)

EZMT MODELING APPROACH

Example Electric Vehicle Corridor Model



Input Modeling Layers

Population Density

Higher suitability in more densely populated areas

Distance to EV Charging Station

Higher suitability in gaps

Distance to Designated EV Corridor

Higher suitability near corridors

Distance to Substation

Higher suitability near substations

Road Traffic Density

Higher suitability for higher traffic areas

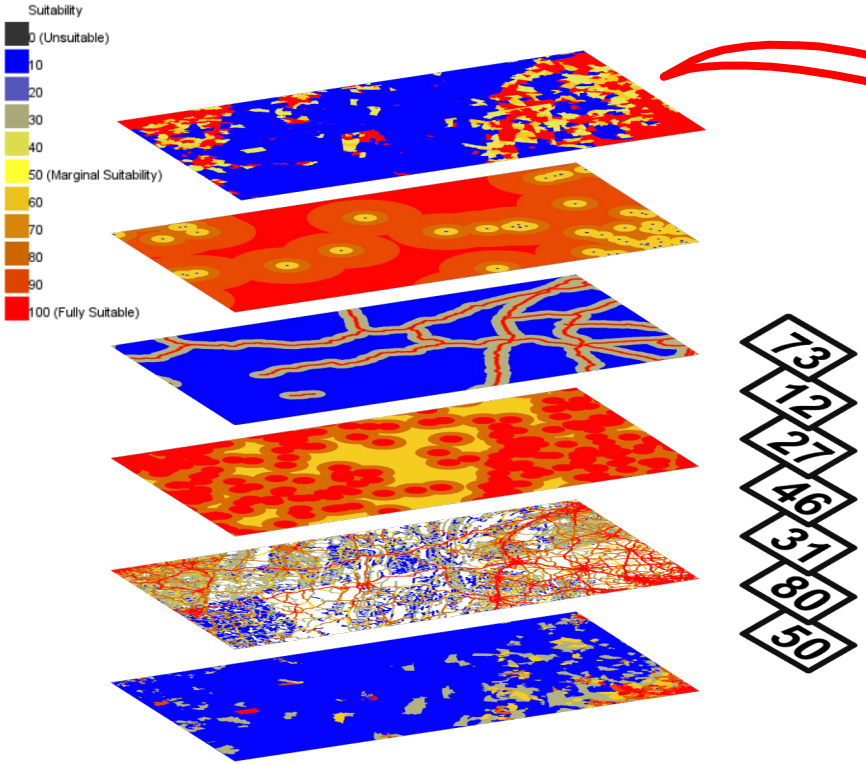
Percent Minority*

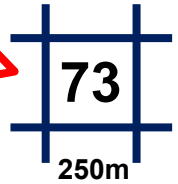
Higher suitability for higher percentages of minorities

*Equity has many dimensions. Identifying metrics and how best to serve the needs and interests of underserved communities is being studied. The equity-related examples in this presentation are for illustration purposes only.

EZMT MODELING APPROACH

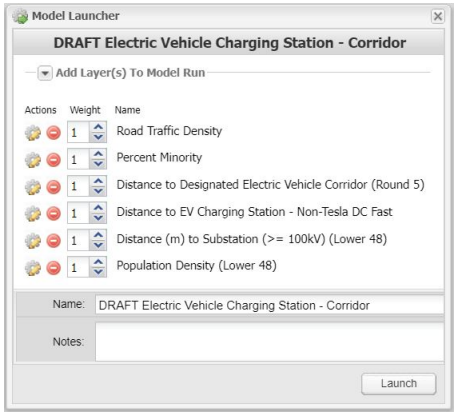
Example Electric Vehicle Corridor Model





Each 250m x 250m cell, in each layer, is coded with a suitability value from 0 (unsuitable) to 100 (highest suitability)

Model Parameters



Composite Score

Weighted Geometric Mean Computation

*Equity has many dimensions. Identifying metrics and how best to serve the needs and interests of underserved communities is being studied. The equity-related examples in this presentation are for illustration purposes only.

EXAMPLE ANALYSIS: WHICH LOCATIONS ARE MOST SUITABLE FOR NEW EVSE INFRASTRUCTURE?

Define model objective and requirements

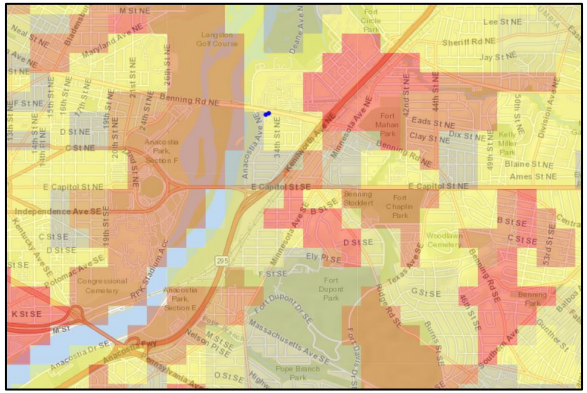
Identify and rank siting criteria

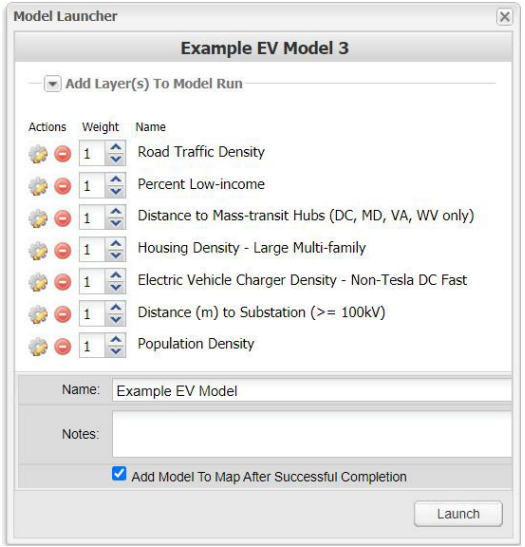
Configure and run model

Validate/review results for model refinements

Highlight locations in **low-income** urban areas with concentrations of large **multi-family structures**, with **high traffic**, near **mass-transit hubs**, near a **substation**, with moderate non-Tesla DC fast **charger density**.

Socio-economic factors
Transportation factors
Utility/Grid factors
Existing EV/EVSE





EVSE/EQUITY EXAMPLES

EXAMPLE A: URBAN TRANSPORTATION NETWORK COMPANY (TNC) MODEL

Objective

Identify high suitability locations for clusters of (6) 150 kW DCFC plugs and (6) Level 2 plugs within areas having higher numbers of rideshare driver residences, and a high demand for ridesharing, to recharge electric TNC vehicles between assignments and between shifts.

EXAMPLE A: CHOOSING SITING CRITERIA

EZMT Modeling Layer	Rationale
Population Density	↑
Road Traffic Density	↑
Land Cover	↑
Distance (m) to Substation	↓
Number of Electric Vehicle Chargers within a 10-Mile Radius (Non-Tesla DC Fast)	↓
Percent minority	↑
Percent low-income	↑
Housing Density - Large Multi-family	↑
Transit Desert Index	↑
Percent of Zero-Vehicle Households	↑

Areas with larger number of drivers and riders

Areas with convenient access to electricity supply

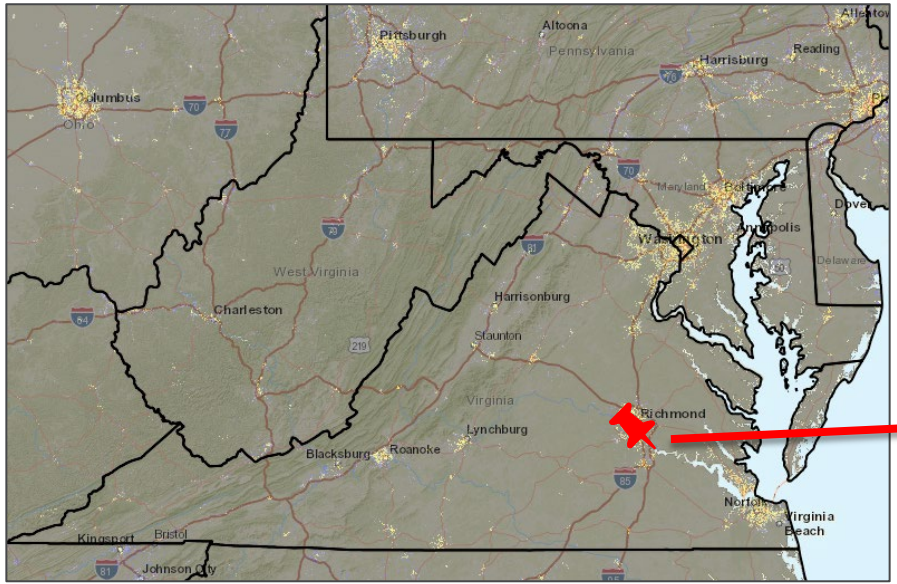
Areas that lack EV charging infrastructures

Areas with more transportation-disadvantaged population and potentially more TNC drivers and riders

↑ Positive factor for EV charging infrastructure

↓ Negative factor for EV charging infrastructure

EXAMPLE A RESULTS: HIGH-SUITABILITY AREAS



Model Results with Example High-suitability Location.

High-Suitability Area in the Whitcomb Neighborhood of Richmond, Virginia.

EXAMPLE B: RURAL AREAS

Objective

Prioritize rural areas lacking nearby non-proprietary DC Fast charging stations, especially where there is higher traffic and sufficient nearby electrical service.

EXAMPLE B: CHOOSING SITING CRITERIA

EZMT Modeling Layer	Rationale
Population Density	↓
Land Cover	↓
Road Traffic Density	↑
Distance (m) to Substation	↓
Number of Electric Vehicle Chargers within a 10-Mile Radius (Non-Tesla DC Fast)	↓

Identify rural areas by selecting regions with relatively low population density and land development intensity

Areas with larger traffic volumes

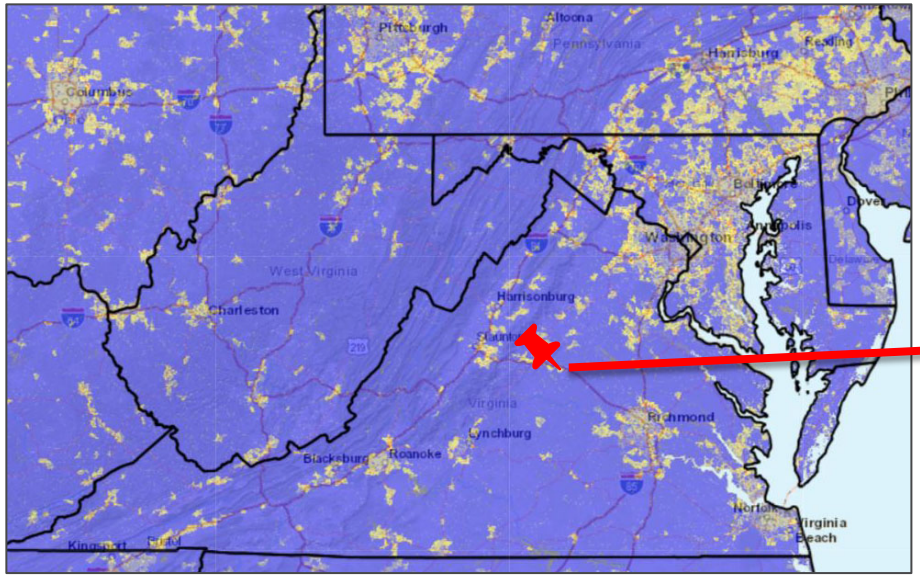
Areas with convenient access to electricity supply

Areas that lack EV charging infrastructures

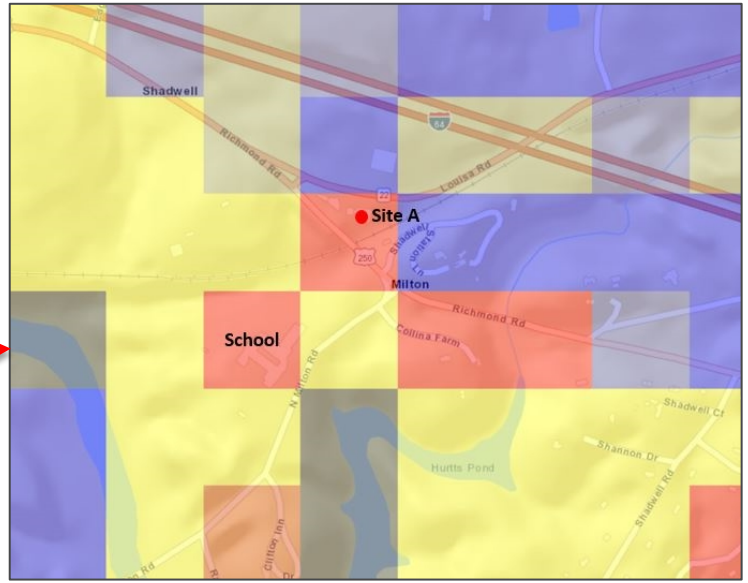
↑ Positive factor for EV charging infrastructure

↓ Negative factor for EV charging infrastructure

EXAMPLE B RESULTS: HIGH-SUITABILITY AREAS



Model Results with Example High-suitability Location.



High-Suitability Area in in Milton, Virginia.

EXAMPLE C: CORRIDOR ANALYSIS

Objective

Identify high suitability locations for DC Fast stations within 5 miles of designated EV alternative fuel corridors, in areas of disadvantaged communities, with high traffic volume, in gaps along the corridors or areas with low numbers of existing public non-proprietary DC Fast charging stations.

EXAMPLE C: CHOOSING SITING CRITERIA

EZMT Modeling Layer	Rationale
Distance to Designated Electric Vehicle Corridor	↓
Distance (m) to Substation (>= 100kV)	↓
Number of Electric Vehicle Chargers within a 10-Mile Radius (Non-Tesla DC Fast)	↓
Road Traffic Density	↑
Population Density	↑
Percent minority	↑

Areas with proximity to EV corridor

Areas with convenient access to electricity supply

Areas that lack EV charging stations

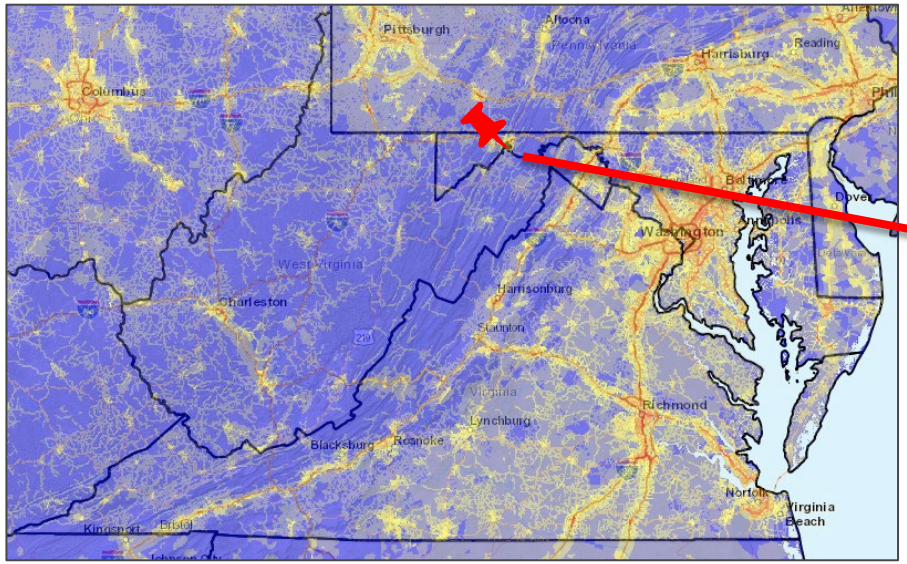
Areas with larger population and traffic volumes

Areas with more transportation-disadvantaged population

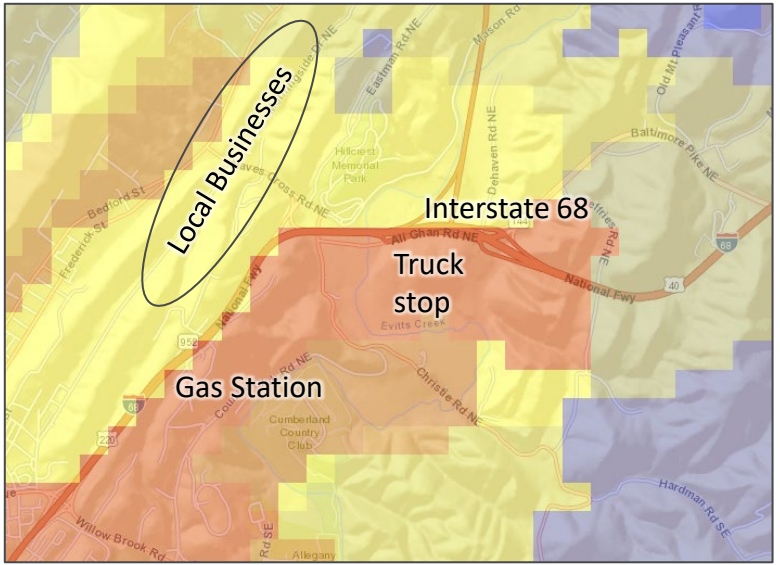
↑ Positive factor for EV charging infrastructure

↓ Negative factor for EV charging infrastructure

EXAMPLE C RESULTS: HIGH-SUITABILITY AREAS



Model Results with Example High-suitability Location.



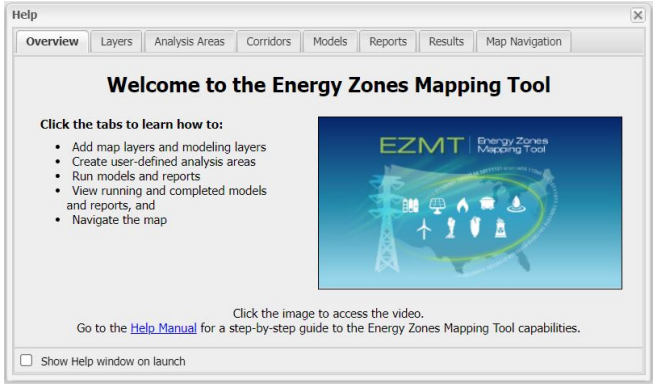
High-Suitability Area in in Cumberland, Maryland.

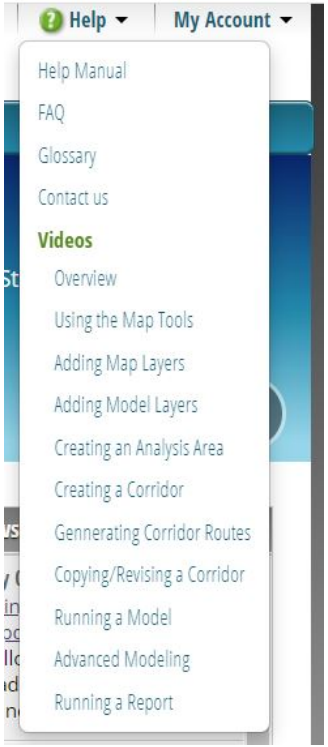
DEMONSTRATION

EXAMPLE LIVE DEMONSTRATION CONTENT REGISTERING AN ACCOUNT

1. **Click Register** at the top right of the https://ezmt.anl.gov home page, then fill out and submit the form.
2. Check for an email confirmation message and **click the link** to confirm your email.
   (If you do not receive an email confirmation message, check your junk folder, or contact ezmt@anl.gov.)
3. **When the account is enabled** by a site administrator, **you will receive an email message**.
   (If you do not receive a response in one working day, contact ezmt@anl.gov.)
4. Return to https://ezmt.anl.gov and click **Launch Tool** on the title bar.

EXAMPLE LIVE DEMONSTRATION CONTENT LEARNING TOOLS AND RECORDED WEBINARS



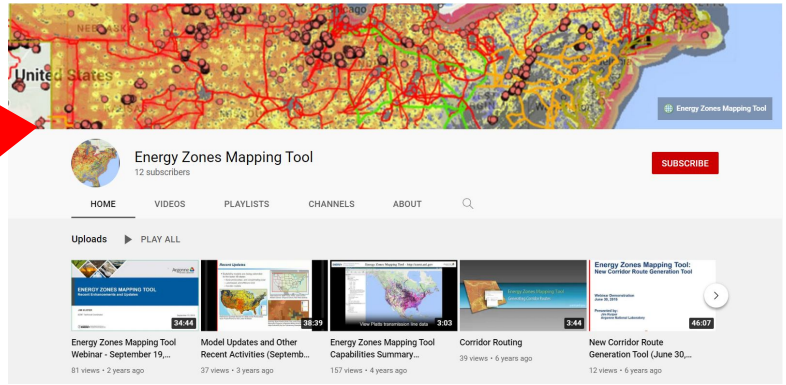


About the Tool

The Energy Zones Mapping Tool is a free online mapping tool to identify potential energy resource areas and energy corridors in the United States.

This web site provides information about the project, background on the energy resources, and details o data layers used in the tool here are also links to documents and related links.

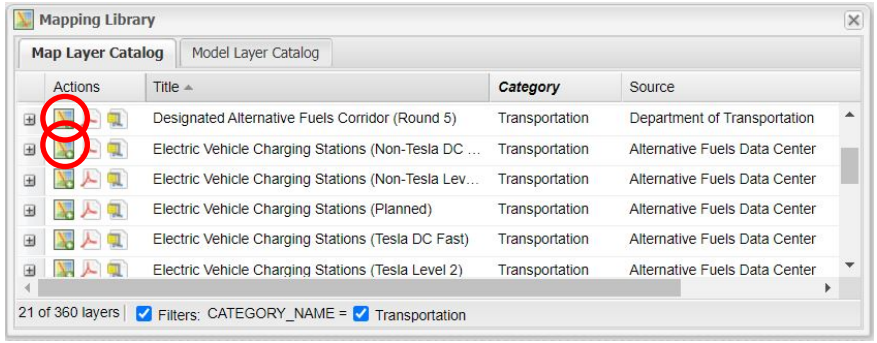
See our YouTube Channel for an archive of EZMT webinars and training videos.



EXAMPLE LIVE DEMONSTRATION CONTENT

Where are the current EV corridors and DC Fast charging stations in my area of interest?

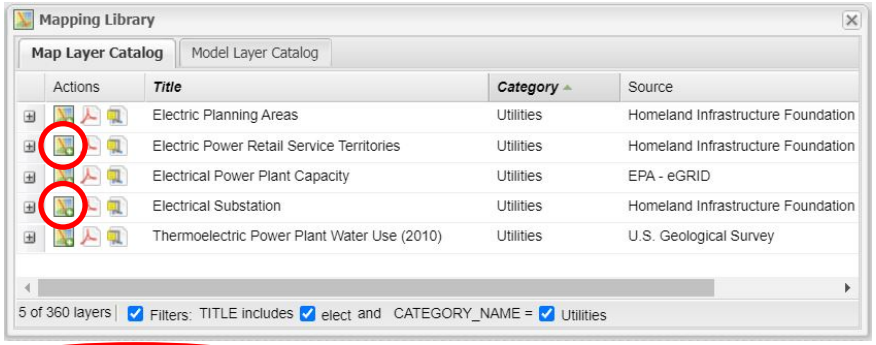
1. Use the Library to add “Designated Alternative Fuels Corridor” and “Electric Vehicle Charging Stations” to the map.
2. Zoom the map to the area of interest.

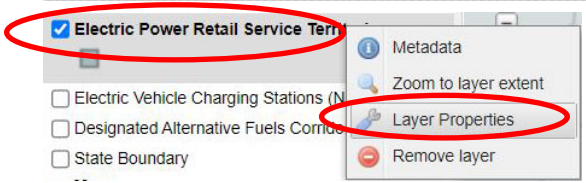


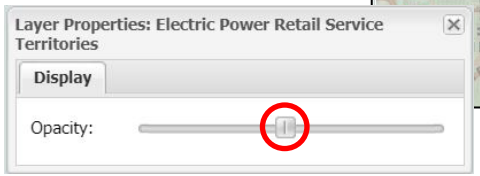
EXAMPLE LIVE DEMONSTRATION CONTENT

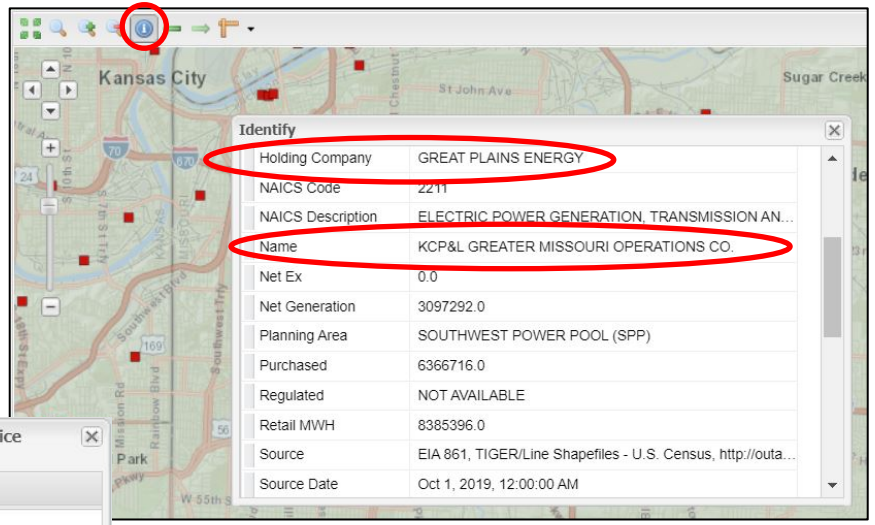
Which electrical service provider owns that substation?

1. Use the Library to add “Electrical Substation” and “Electric Power Retail Service Territories” to the map.
2. Right-click on Electric Power Retail Service Territories in the Table of Contents, choose Properties, and adjust the opacity to about 50%.
3. Use the Identify tool to look up features of interest.





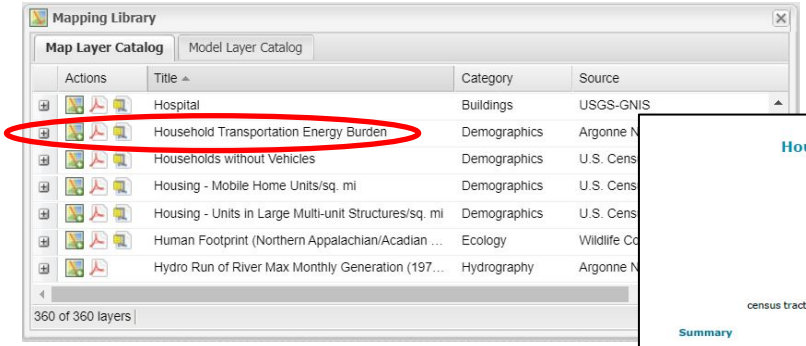


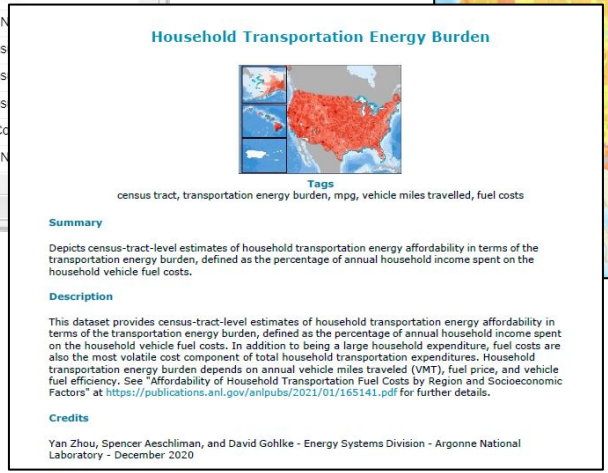


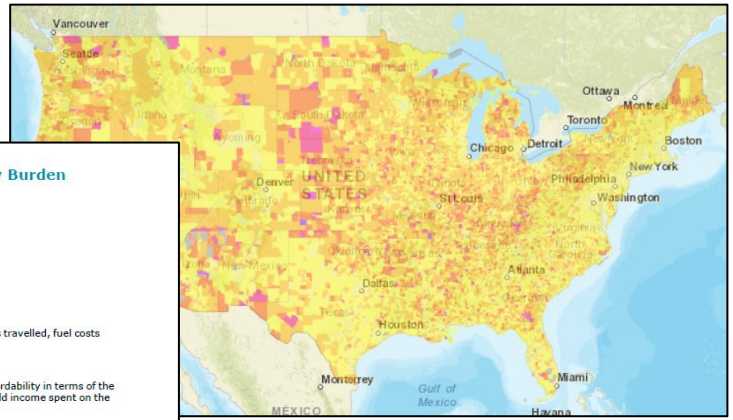
EXAMPLE LIVE DEMONSTRATION CONTENT

Where can I obtain a copy of the household transportation energy burden data?

1. Use the Library to find “Household Transportation Energy Burden”.
2. Click the Download Data action.
   also optionally…
3. Click the Metadata action to learn more about the data, including a link to the study document.
4. Click the Add to Map action to view it on the map.



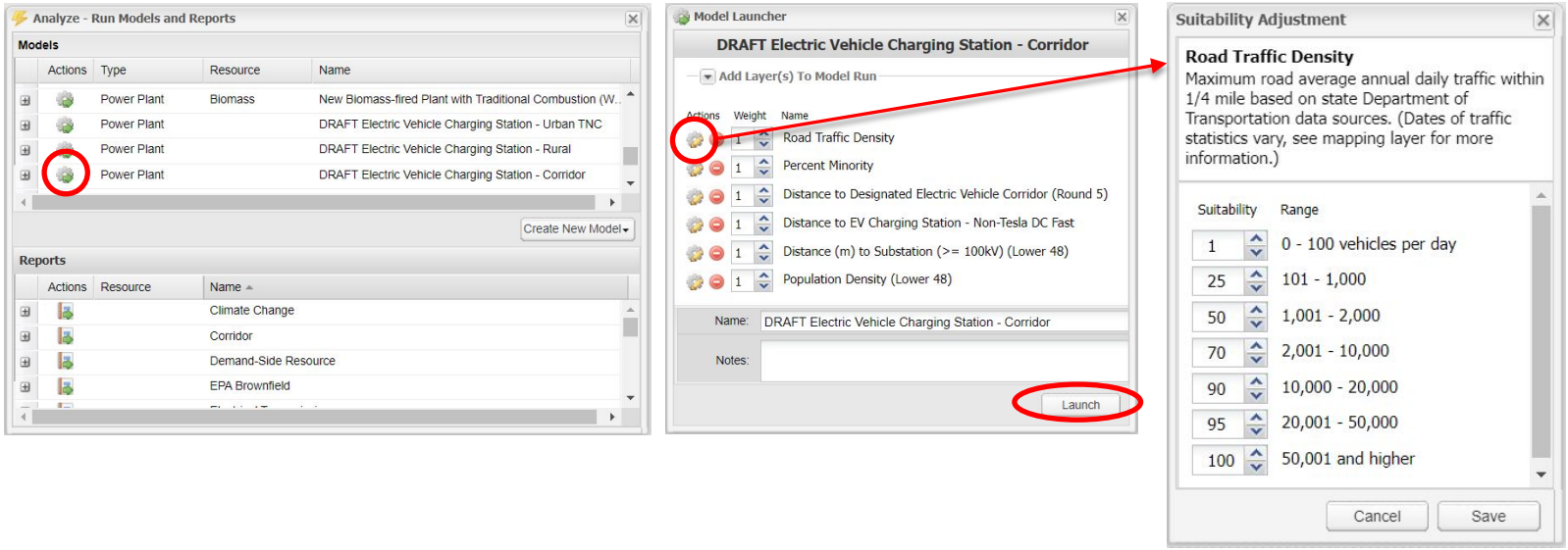




EXAMPLE LIVE DEMONSTRATION CONTENT

Where should we prioritize EVSE siting investments to fill gaps along a designated EV corridor?

1. Click Analyze, scroll the top section to dialog to the “Electric Vehicle Charging Station – Corridor” model, then click the gear icon.
2. Inspect the default model settings in the Model Launcher Dialog, revise if desired, then click Launch.
   …

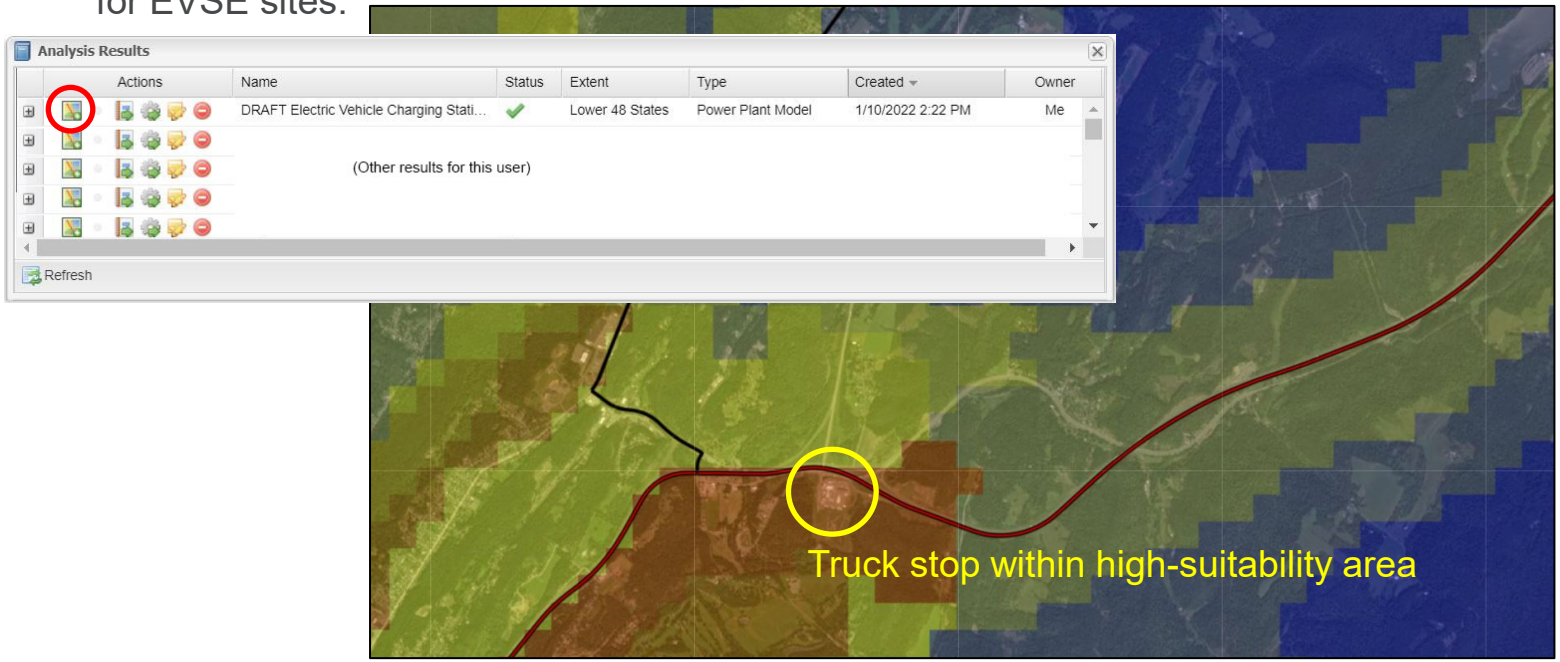


EXAMPLE LIVE DEMONSTRATION CONTENT

Where should we prioritize EVSE siting investments to fill gaps along a designated EV corridor?

…

3. Click “Results” When the model is finished running, click the Add results to map Action.
4. Inspect the model results on the map, especially in higher suitability areas, to look for opportunities for EVSE sites.

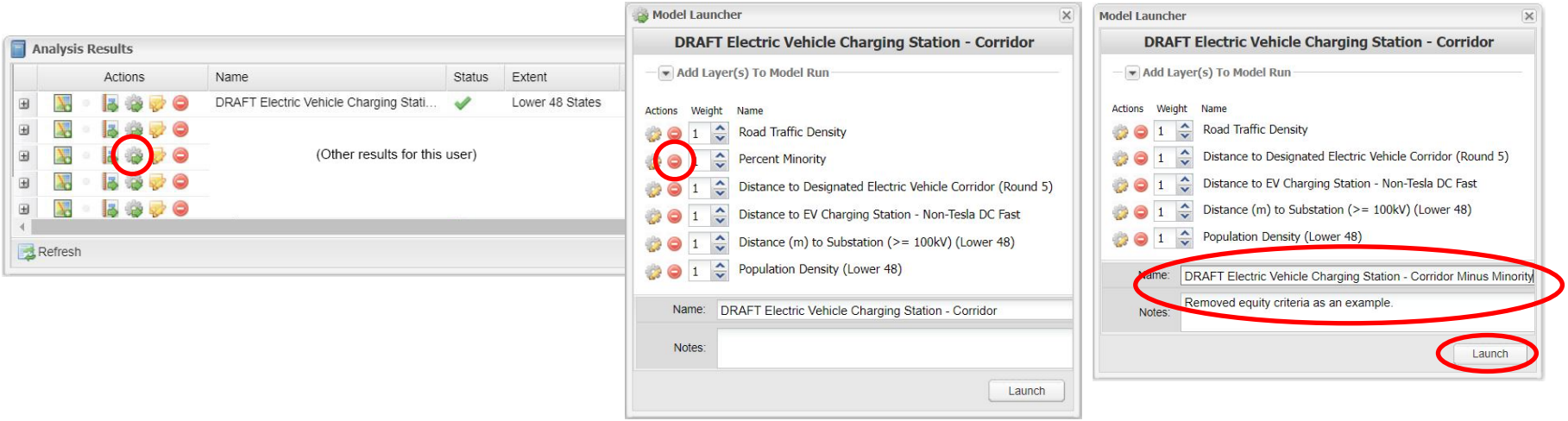


EXAMPLE LIVE DEMONSTRATION CONTENT

What changes if we add equity to the analysis? (Comparing two models)
(The previous example included equity measures. Here we'll run the same model without the equity criteria.) Continuing from that example…

1. Click on Results, then click the gear icon for the prior run of the corridor model.
2. Use the Remove layer action to remove the Minority criteria from the model, update the name and notes, and click Launch (this runs a new copy of the model without changing the prior one).

…

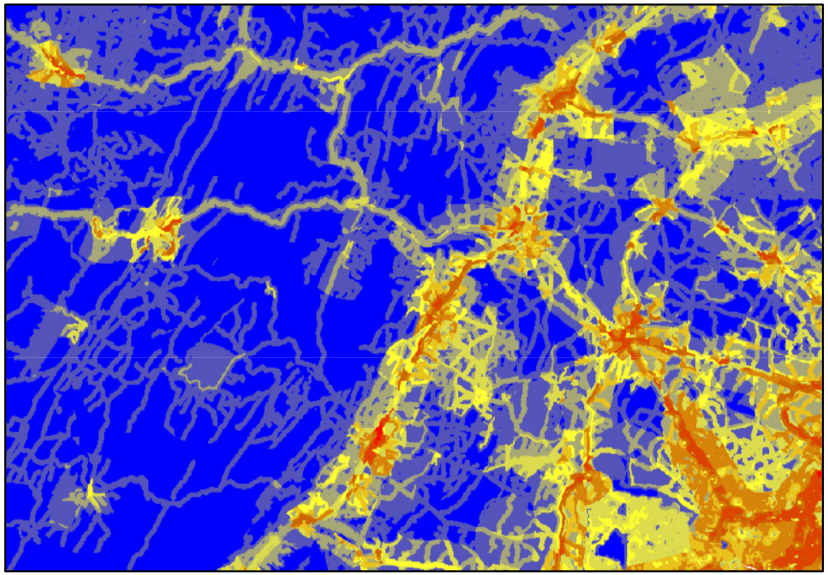


EXAMPLE LIVE DEMONSTRATION CONTENT

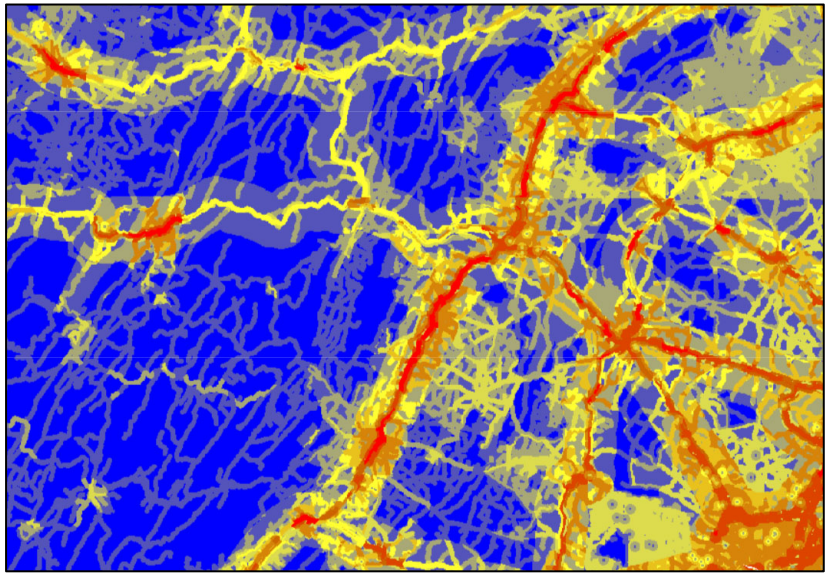
What changes if we add equity to the analysis? (Comparing two models)

…

3. Add both versions of the model to the map (see previous example for steps)
4. Toggle the top model results on and off on the map, looking for differences.
   (Focus on comparing which areas have high suitability. Models are not comparable quantitatively)



Corridor model with minority criterion

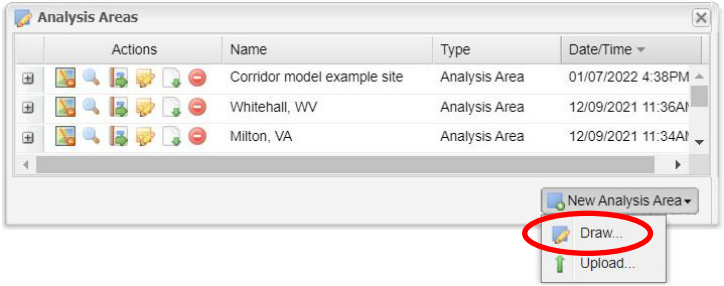


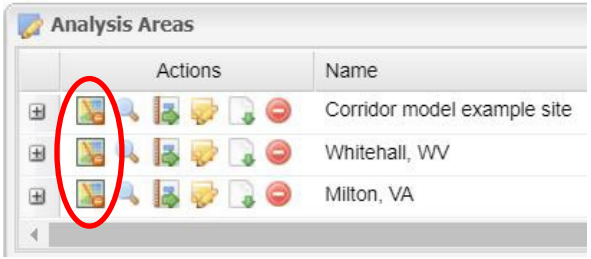
Corridor model without minority criterion

EXAMPLE LIVE DEMONSTRATION CONTENT

Which of these three potential sites is the best? or
Do the locations we chose meet our equity objectives?

1. Locate the sites to compare on the map. One way is to map them as analysis areas: Click “Areas”, then New Analysis Area, then Draw to sketch each area on the map).
2. Make sure “My Analysis Areas” is toggled on in the Table of Contents to display the areas, and in the Analysis Areas dialog, make sure the areas are shown on the map with the show/hide action.
   …



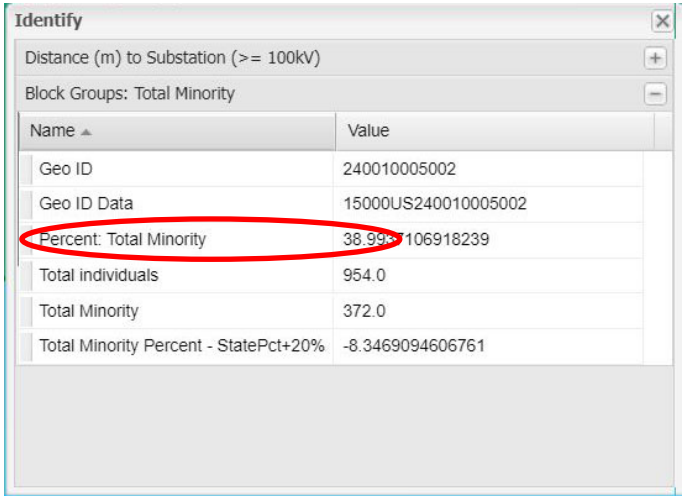


EXAMPLE LIVE DEMONSTRATION CONTENT

Which of these three potential sites is the best?

…

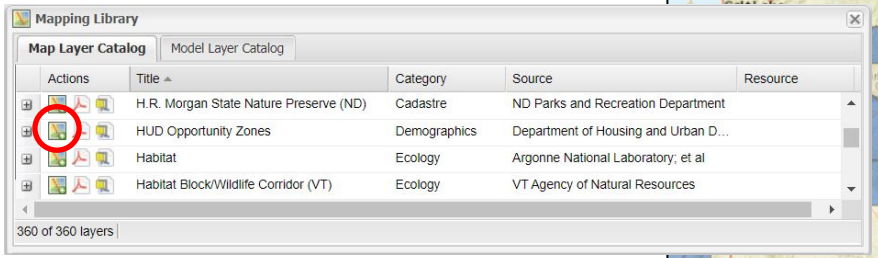
3. Decide on metrics for comparison – mapping layers, modeling layers, or model results.
4. Add the layers to the map, (see prior example) all displayed at the same time.
5. Zoom to each analysis area and click the map with the Identify tool (see prior example). The dialog will show data from each layer at the click point.
6. The map can be moved rapidly to the sites being compared with the Analysis Areas “Zoom To” action.

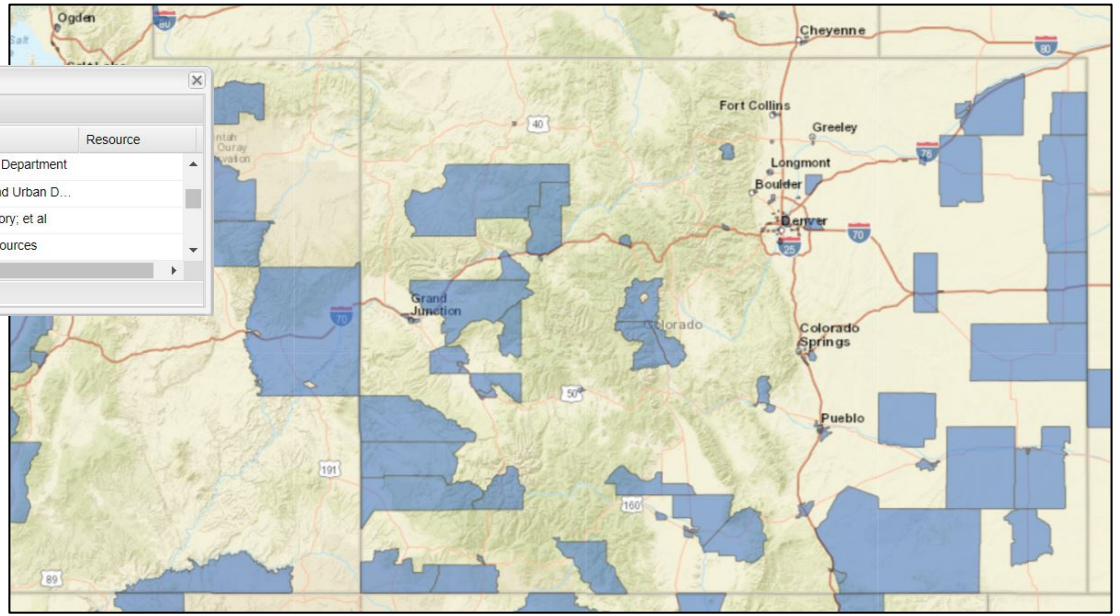


EXAMPLE LIVE DEMONSTRATION CONTENT

Where might we be able to leverage federal funds to help underserved areas?

1. Use the Library to add “Electrical Substation” and “Electric Power Retail Service Territories” to the map.
2. Adjust the opacity to about 50% (see prior example)
3. Examine the map for areas of interest within the opportunity zones.
4. Consult https://opportunityzones.hud.gov to learn more about the opportunities.



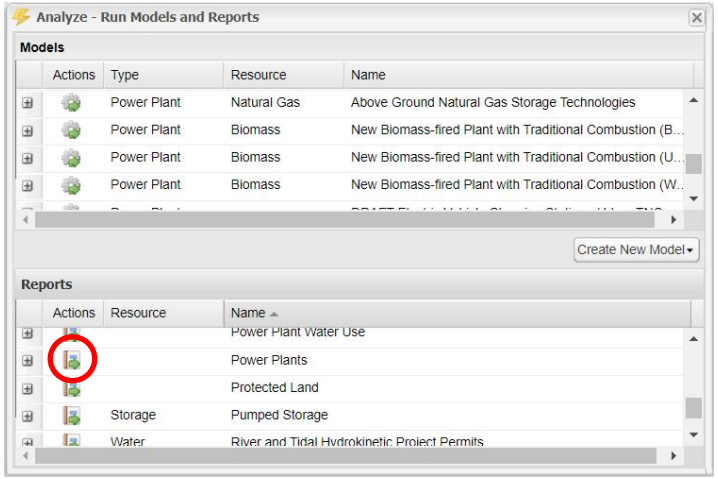


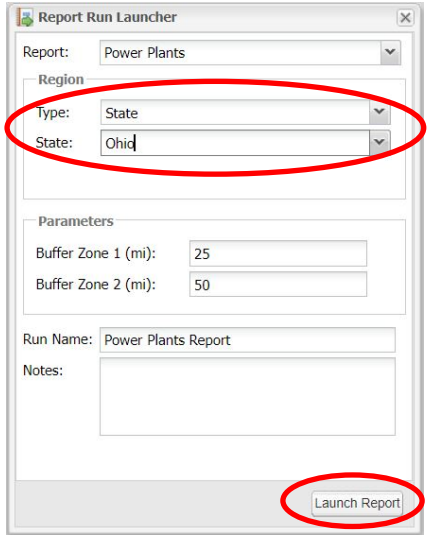
EXAMPLE LIVE DEMONSTRATION CONTENT

How much of Ohio's power generation is from renewable sources?

1. Click Analyze, scroll the lower panel to "Power Plants", and click the "Run this report" action
2. In the Report Run Launcher, choose State as the type, then Ohio from the state list.
3. Click Launch Report.

…



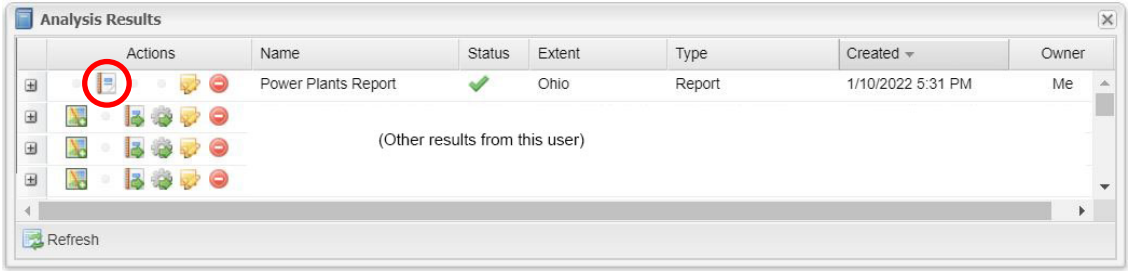


EXAMPLE LIVE DEMONSTRATION CONTENT

How much of Ohio's power generation is from renewable sources?

…

4. Click "Results" The report run will be listed.
5. When the report is complete, click the "Display the generated report" action. It will open in a new tab.
6. Review the report to find that Ohio has 153.6 MW capacity from biomass, 31.7 from hydro, 98.3 from solar and 718.4 from wind, of the total capacity of 28,337.2 MW. About 3.5% of Ohio's capacity is renewable.
7. Click the link below the table to learn about the data the report is based on.



Primary Energy Resource Type	Total Number within Analysis Area	Total Total Capacity (MW) within Analysis Area
natural gas	42	12,886.00
nuclear	2	2,134.00
petroleum	38	462.60
biomass	19	153.60
hydroelectric	4	31.70
coal	12	11,632.50
batteries	6	33.00
other	4	187.10
solar	25	98.30
wind	18	718.40
TOTAL	170	28,337.20

Source: U.S. Energy Information Administration(Power Plant (EIA)).

THANK YOU!

Jim Kuiper - JKuiper@anl.gov
Xinyi (Sydney) Wu - xinyi.wu@anl.gov

Questions?

This work is supported by the Vehicle Integration Program in the USDOE's Office of Energy Efficiency and Renewable Energy, and the USDOE Office of Electricity, under Contract DE-AC02-06CH11357.

ABSTRACT

The Energy Zones Mapping Tool (EZMT) has been updated for electric vehicle (EV) charging station mapping and modeling, including an emphasis on equity.

Join Argonne's Jim Kuiper as he will highlight the new mapping data, and how to use the new models to help identify potential locations for EV charging stations.

Equity data, such as percent low-income, percent minority, household transportation energy burden, multi-family housing density, manufactured housing density, and many others can be included in the EV analysis or any of the other suitability models in the system.