Examining Electrical Vehicle Charging Accessibility in the United States

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Recent Events

VW expects half of U.S. sales to be electric vehicles by 2030

AEP, Dominion Energy, Duke Energy, Entergy, Southern Company and TVA Plan to Add Electric Vehicle Fast Chargers to Connect Gulf Coast, Midwest and Atlantic State Destinations

President Biden’s American Jobs Plan includes a transformational $15 billion investment to fund this vision and build a national network of 500,000 charging stations. Through a combination of grant and incentive programs for state and local governments and the private sector, it will support a transformational acceleration in deployment of a mix of chargers in apartment buildings, in public parking, throughout communities, and as a robust fast charging along our nation’s roadways.
Overview

• Research Objectives
• Past Research
• Justification: EV Ownership Rates
• Justification: GHG Emissions
• Defining Accessibility
• Background: Electrical Charger Types
• CAPCOG Population Demographics
• CAPCOG: Income and Charging Station Demographics
• Timeline
• Research Approach
• Examples of Aggregation Tools and Workflows
• Preliminary Results of Network Analysis on a Sample Area
• Limitations
• References
Research Objectives

- Analysis of Electrical Vehicle Charging Infrastructure in the Capital Area Council of Governments of Texas (CAPCOG)
- This research will focus on the locational relationship between electrical vehicle charging stations infrastructure and accessibility to job areas, retail, entertainment, and parks.
- This study will also examine local socio-economic demographics of census blocks in proximity to charging station locations
Past Research on the Electrical Charging Station Network

- California public electric vehicle charging stations’ accessibility to amenities: A GIS network analysis approach (Chen, 2017)

- Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, Ohio (NREL, 2018)

- Measuring the impacts of new public transit services on space-time accessibility: An analysis of transit system redesign and new bus rapid transit in Columbus, Ohio (Lee & Miller, 2018)
Justification:
Electrical Vehicle Ownership Rates
Justification: Green House Gas Emissions
Defining Accessibility

- **Travel Cost:**
  - Time and Distance

- **Attractiveness of Destination:**
  - Shopping centers, workplaces, and recreational centers (parks, etc.)

- **Unit of Measurement:**
  - Time: retail, workplaces, and recreational centers within 10 minutes of an electrical charging station
  - Distance: retail, workplaces, and recreational centers within .25 of an electrical charging station

- **Limitation:** Distance Decay
Background:
Electrical Vehicle Charger Types

- **Level 1**
- **Level 2**
- **Direct Current Fast Charge**
Mean: 242,914 | Minimum: 11,757 | Maximum: 1,318,171

Mean: 250.13 | Minimum: 16.50 | Maximum: 1,285.80
CAPCOG: Income and Charging Station Demographics

Comparison of 2019 Median HH Income (ACS 5-Yr) by County

<table>
<thead>
<tr>
<th>County Name</th>
<th>2019 Median HH Income (ACS 5-Yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bastrop County</td>
<td>$55,000</td>
</tr>
<tr>
<td>Blanco County</td>
<td>$65,100</td>
</tr>
<tr>
<td>Burleson County</td>
<td>$74,924</td>
</tr>
<tr>
<td>Caldwell County</td>
<td>$54,394</td>
</tr>
<tr>
<td>Fayette County</td>
<td>$52,842</td>
</tr>
<tr>
<td>Hill County</td>
<td>$67,246</td>
</tr>
<tr>
<td>Llano County</td>
<td>$55,360</td>
</tr>
<tr>
<td>Mason County</td>
<td>$62,750</td>
</tr>
<tr>
<td>Travis County</td>
<td>$75,546</td>
</tr>
<tr>
<td>Williamson County</td>
<td>$85,076</td>
</tr>
</tbody>
</table>
Timeline

May–June 2021
- Develop/finalize Capstone Proposal
- Create scripting tools and aggregate datasets
- Gather further data

July–Aug. 2021
- Conduct preliminary analysis
- Evaluate results and refine methodology/datasets
- Start draft of final paper

Sep.–Oct. 2021
- Conduct final analysis on datasets
- Begin writing final paper
- Select and develop demonstration for Capstone Presentation

Nov.–Dec. 2021
- Present Capstone Presentation
Research Approach

Gather

• Datasets
• Past research results & methods
• Speak with government officials and researchers

Build

• “Service Areas” and produce isochrone maps detailing accessibility per charging station location
• Workflows to aggregate electrical charging station locations, electrical vehicle registration, and building address points
• Automatize scripting tools
• Template layouts and reports
• Standardized accessibility weight measurement

Analyze

• Relationships between electrical charging station locations, electrical vehicle registrations, socioeconomic demographics, and available destination types
• Public policy initiatives
• Charging station network through overlay, buffer, and network analysis

Report

• Results of network analysis on the CAPCOG region by county
• On the overall accessibility of electrical charging stations in CAPCOG region
<table>
<thead>
<tr>
<th>Layer Name</th>
<th>Source</th>
<th>Update Date</th>
<th>Data Type</th>
<th>Description of Dataset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Charging Station Locations</td>
<td>Alternative Fuels Data Center (AFDC)</td>
<td>04-11-2021</td>
<td>Point</td>
<td>This dataset contains the geographic location of electrical vehicle charging stations in Texas</td>
</tr>
<tr>
<td>County Boundaries</td>
<td>Capitol Area Council of Governments (CAPCOG)</td>
<td>04-17-2020</td>
<td>Polygon</td>
<td>This dataset defines the geographic boundaries of CAPCOG and associated counties</td>
</tr>
<tr>
<td>Road Network Center Lines</td>
<td>Capitol Area Council of Governments (CAPCOG)</td>
<td>04-12-2021 (Monthly)</td>
<td>Polyline</td>
<td>This dataset defines the local road network in the CAPCOG region and is classified by road type</td>
</tr>
<tr>
<td>Address Points of Locations</td>
<td>Capitol Area Council of Governments (CAPCOG)</td>
<td>04-12-2021 (Monthly)</td>
<td>Point</td>
<td>This dataset defines all address points within the CAPCOG region and is classified by building type</td>
</tr>
<tr>
<td>City Limits of CAPCOG Region</td>
<td>Capitol Area Council of Governments (CAPCOG)</td>
<td>04-12-2021</td>
<td>Polygon</td>
<td>This dataset defines the geographic boundaries of all towns/cities in the CAPCOG region</td>
</tr>
<tr>
<td>2020 Census Tracts/Blocks/Block Groups of CAPCOG Region</td>
<td>United States Census Bureau</td>
<td></td>
<td>Polygon</td>
<td>This dataset defines the geographic boundaries and their associated socio-economic demographics</td>
</tr>
<tr>
<td>Electrical Vehicle Registrations by Zip code</td>
<td>Dallas-Fort Worth Clean Cities Coalition</td>
<td>04-06-2021 (Monthly)</td>
<td>(.csv file) Longitude and Latitude Coordinates</td>
<td>This dataset defines the geographic location and month of registration of electrical vehicles in Texas</td>
</tr>
</tbody>
</table>
Charging Station Dataset Aggregation/Filtering Tool
CAPCOG County, City/Town, and Census Block Creation Tool
Preliminary Results of Network Analysis on a Sample Area
Data and Infrastructure Limitations

<table>
<thead>
<tr>
<th>Data and Infrastructure Limitations</th>
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<tbody>
<tr>
<td>Modifiable Areal Unit Problem (MAUP)</td>
</tr>
<tr>
<td>• Shape or zonation effect</td>
</tr>
<tr>
<td>• Aggregation effect</td>
</tr>
<tr>
<td>EVSE Charger Levels and Connector Types</td>
</tr>
<tr>
<td>BEV Car Manufacture, Model, Series, and Year Produced</td>
</tr>
<tr>
<td>Defining Accessibility</td>
</tr>
</tbody>
</table>
References

- https://regional-open-data-capcog.opendata.arcgis.com/datasets/address-points-apr2021
- https://www.transportation.scdoh.sc.gov/health/connectivity
- https://www.wpt.go.kr/smartphone/mobile-location-mapping#SOL
- https://access.umn.edu/research/national/edir/2019/index.html
Question Time
## Terminology

<table>
<thead>
<tr>
<th>Acronyms</th>
<th>Definition</th>
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<tbody>
<tr>
<td>CAPCOG</td>
<td>Capital Area Council of Governments of Texas</td>
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<tr>
<td>BEV</td>
<td>Battery Electric Vehicle</td>
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<tr>
<td>EV</td>
<td>Electric Vehicle</td>
</tr>
<tr>
<td>EVSE</td>
<td>Electric Vehicle Supply Equipment</td>
</tr>
<tr>
<td>L1</td>
<td>Level 1 Charging Station</td>
</tr>
<tr>
<td>L2</td>
<td>Level 2 Charging Station</td>
</tr>
<tr>
<td>DCFC</td>
<td>Direct Current (DC) Fast Charging Station</td>
</tr>
<tr>
<td>MUD</td>
<td>Multi-Unit Dwelling</td>
</tr>
<tr>
<td>SUD</td>
<td>Single-Unit Dwelling</td>
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</tbody>
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